US009256417B2

(12) **United States Patent**
Tagliabue

(10) **Patent No.: US 9,256,417 B2**
(45) **Date of Patent: *Feb. 9, 2016**

(54) **AUTOMATIC QUALITY ASSURANCE FOR SOFTWARE INSTALLERS**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **14/522,637**

(22) Filed: **Oct. 24, 2014**

(65) **Prior Publication Data**

US 2015/0046917 A1 Feb. 12, 2015

Related U.S. Application Data

(63) Continuation of application No. 13/826,961, filed on Mar. 14, 2013, now Pat. No. 8,918,780.

(51) **Int. Cl.**

G06F 9/445	(2006.01)
G06F 3/12	(2006.01)
G06F 11/07	(2006.01)
G06F 17/21	(2006.01)

(52) **U.S. Cl.**

CPC ***G06F 8/61*** (2013.01); ***G06F 3/1204*** (2013.01); ***G06F 3/1225*** (2013.01); ***G06F 3/1285*** (2013.01); ***G06F 8/62*** (2013.01); ***G06F 11/07*** (2013.01); *G06F 17/211* (2013.01)

(58) **Field of Classification Search**

None

See application file for complete search history.

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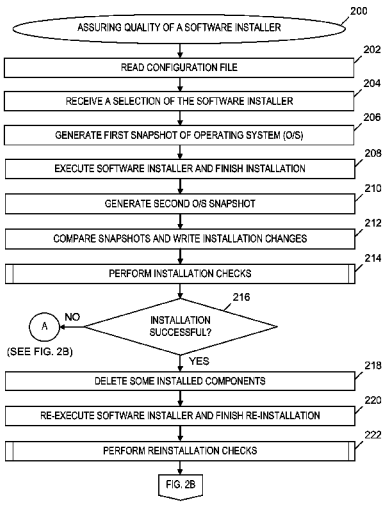
(57) **ABSTRACT**

An approach for assuring quality of a software installer is presented. A change between first and second views of an operating system is determined. The second view is recorded after executing an installer to create installed software application components. The installation is determined to be successful. A location for an installed shortcut for the software application is determined. Executable and command line information inside the shortcut is extracted using the location. Based on the extracted executable and command line information, the application is executed to perform a test of the application. While the application is executing, a close signal is sent to a window of the application. An exit code from the application is read. If the exit code matches a standard exit code, the test is documented as being successful. If the exit code does not match the standard exit code, the test is documented as being unsuccessful.

20 Claims, 10 Drawing Sheets



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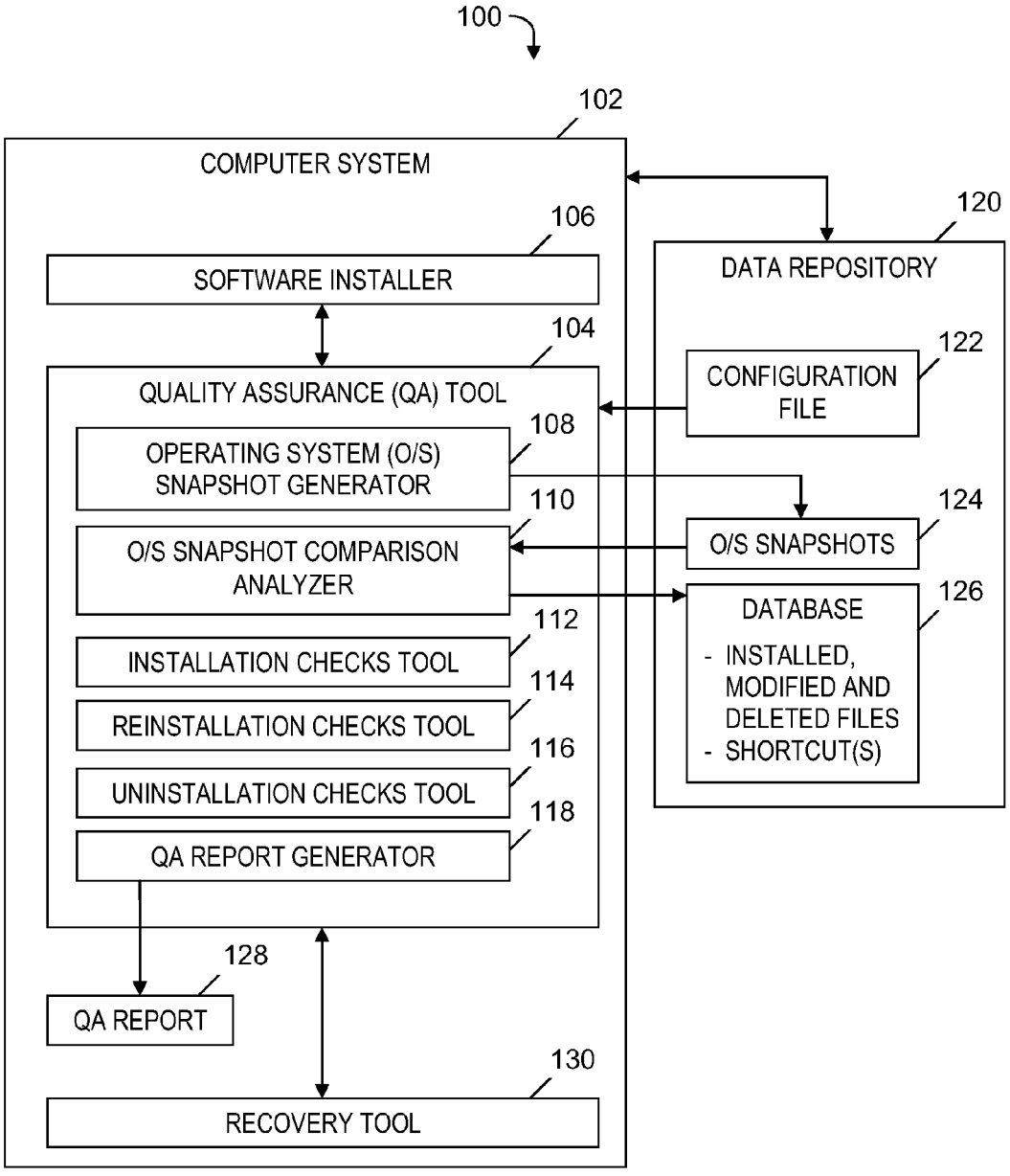
100
102
COMPUTER SYSTEM
106
SOFTWARE INSTALLER
104
QUALITY ASSURANCE (QA) TOOL
108
OPERATING SYSTEM (O/S) SNAPSHOT GENERATOR
110
O/S SNAPSHOT COMPARISON ANALYZER
112
INSTALLATION CHECKS TOOL
114
REINSTALLATION CHECKS TOOL
116
UNINSTALLATION CHECKS TOOL
118
QA REPORT GENERATOR
128
QA REPORT
130
RECOVERY TOOL
120
DATA REPOSITORY
122
CONFIGURATION FILE
124
O/S SNAPSHOTS
126
DATABASE
- INSTALLED, MODIFIED AND DELETED FILES
- SHORTCUT(S)

FIG. 1

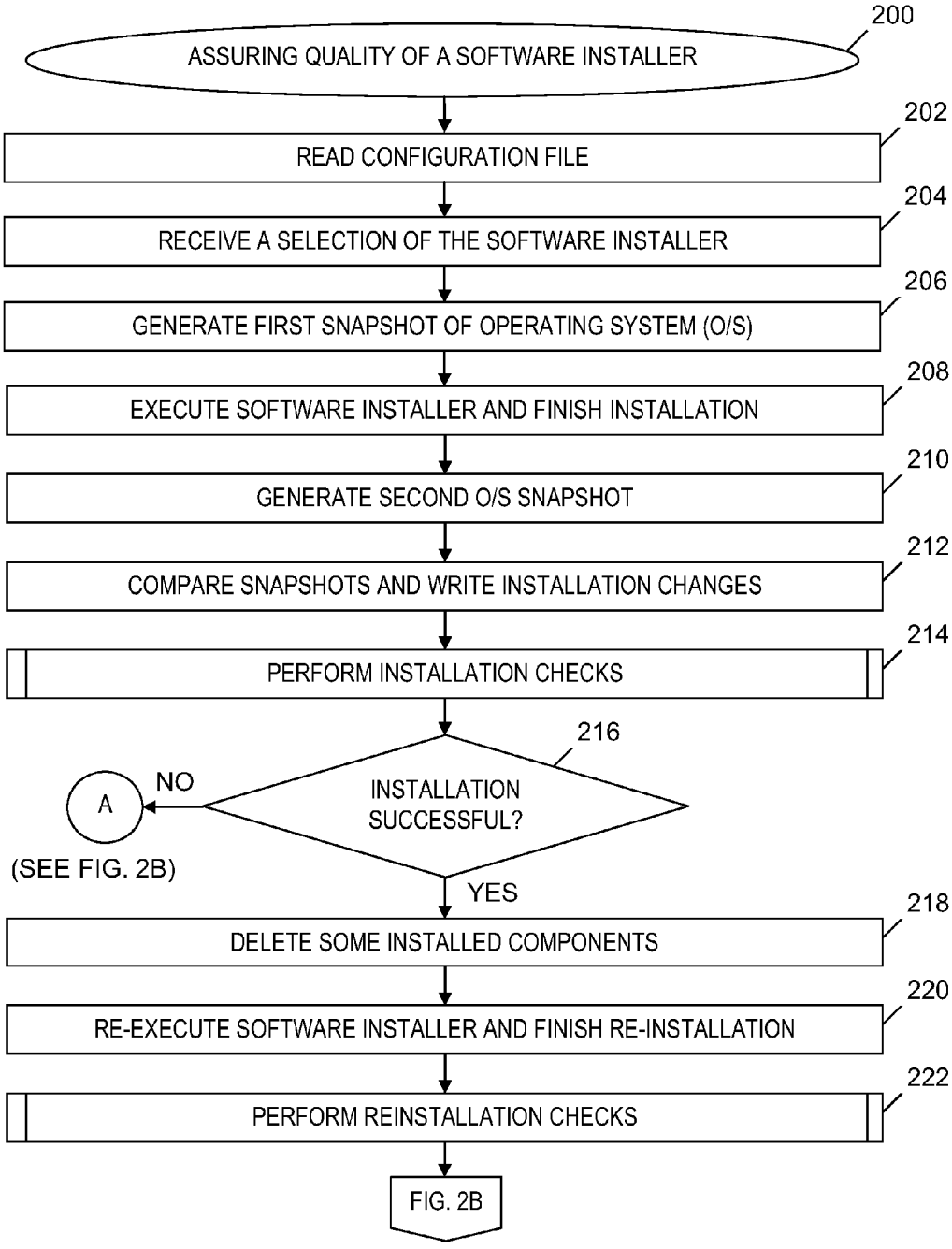
200
ASSURING QUALITY OF A SOFTWARE INSTALLER
202
READ CONFIGURATION FILE
204
RECEIVE A SELECTION OF THE SOFTWARE INSTALLER
206
GENERATE FIRST SNAPSHOT OF OPERATING SYSTEM (O/S)
208
EXECUTE SOFTWARE INSTALLER AND FINISH INSTALLATION
210
GENERATE SECOND O/S SNAPSHOT
212
COMPARE SNAPSHOTS AND WRITE INSTALLATION CHANGES
214
PERFORM INSTALLATION CHECKS
216
INSTALLATION SUCCESSFUL?
NO
A
(SEE FIG. 2B)
YES
218
DELETE SOME INSTALLED COMPONENTS
220
RE-EXECUTE SOFTWARE INSTALLER AND FINISH RE-INSTALLATION
222
PERFORM REINSTALLATION CHECKS
FIG. 2B

FIG. 2A

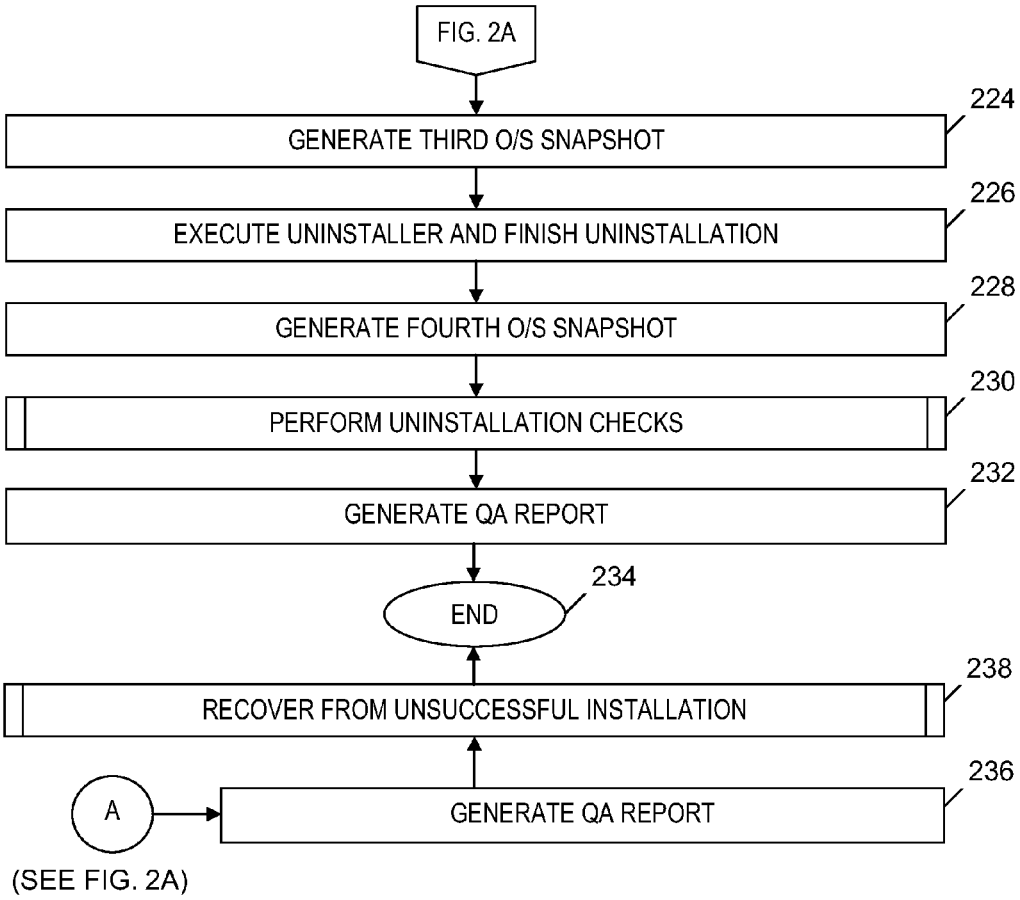
FIG. 2A
224
GENERATE THIRD O/S SNAPSHOT
226
EXECUTE UNINSTALLER AND FINISH UNINSTALLATION
228
GENERATE FOURTH O/S SNAPSHOT
230
PERFORM UNINSTALLATION CHECKS
232
GENERATE QA REPORT
234
END
238
RECOVER FROM UNSUCCESSFUL INSTALLATION
236
A
GENERATE QA REPORT
(SEE FIG. 2A)

FIG. 2B

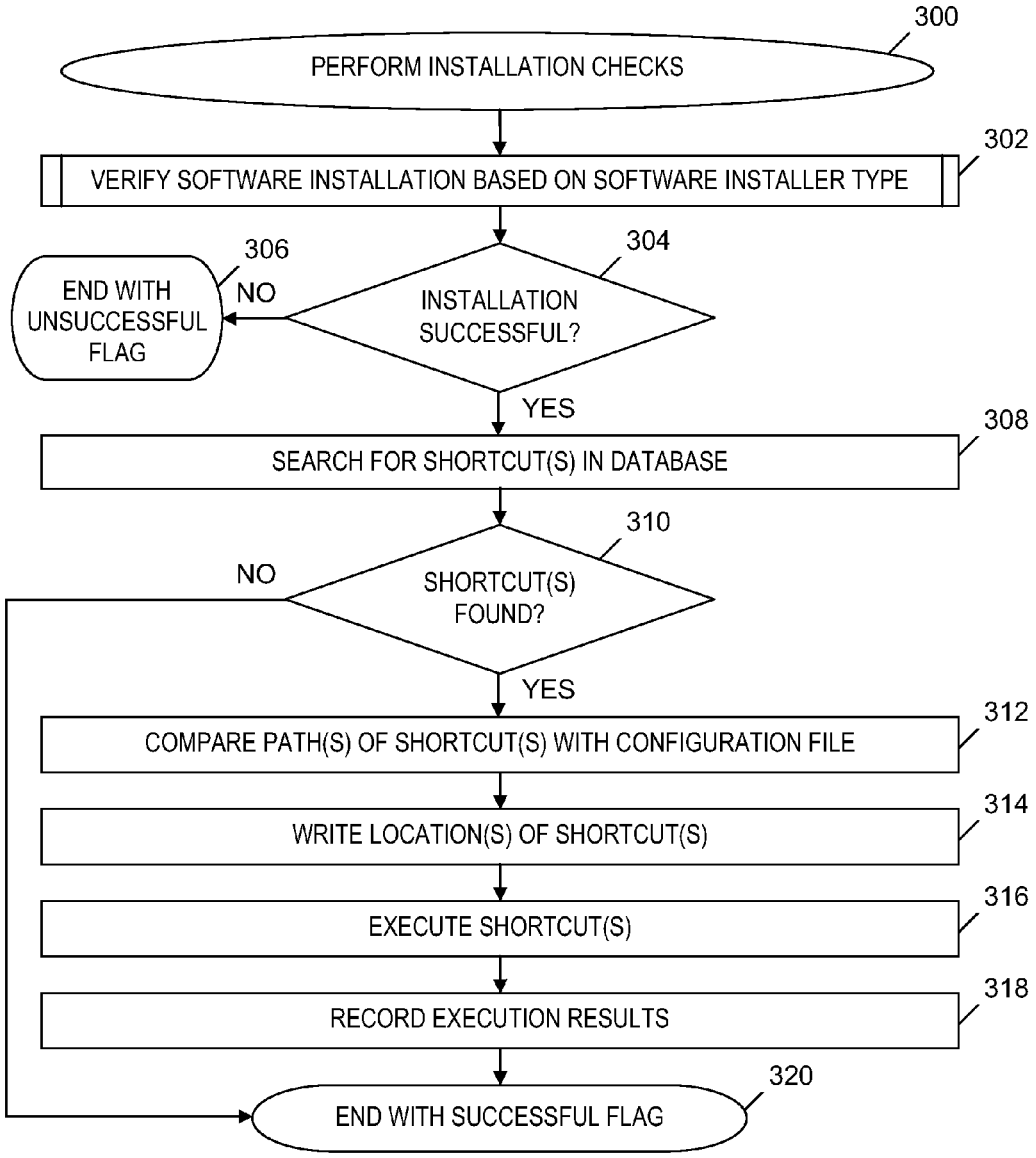
300
PERFORM INSTALLATION CHECKS
302
VERIFY SOFTWARE INSTALLATION BASED ON SOFTWARE INSTALLER TYPE
304
INSTALLATION SUCCESSFUL?
NO
306
END WITH UNSUCCESSFUL FLAG
YES
308
SEARCH FOR SHORTCUT(S) IN DATABASE
310
SHORTCUT(S) FOUND?
NO
YES
312
COMPARE PATH(S) OF SHORTCUT(S) WITH CONFIGURATION FILE
314
WRITE LOCATION(S) OF SHORTCUT(S)
316
EXECUTE SHORTCUT(S)
318
RECORD EXECUTION RESULTS
320
END WITH SUCCESSFUL FLAG

FIG. 3A

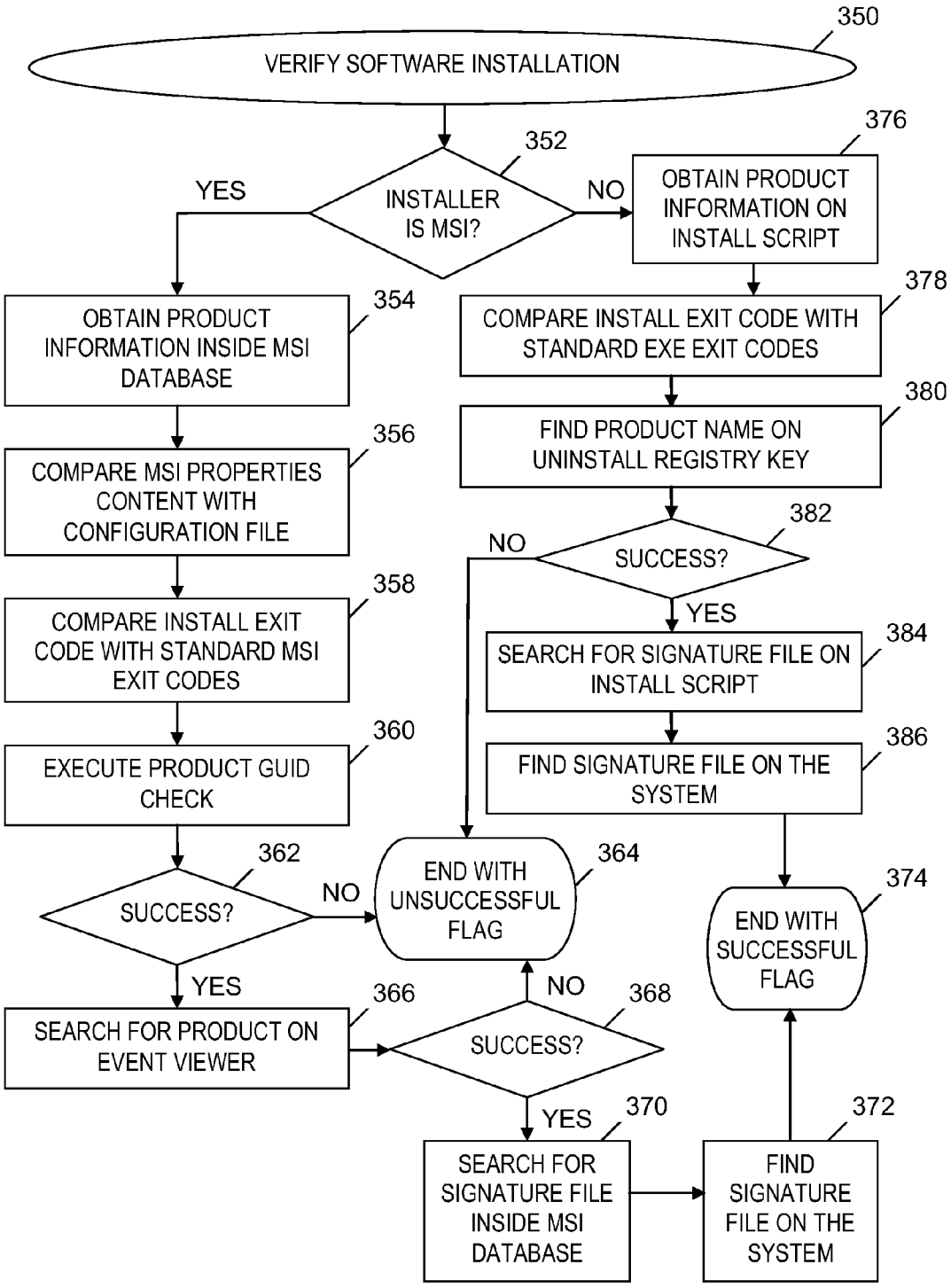
350
VERIFY SOFTWARE INSTALLATION
352
INSTALLER IS MSI?
YES
NO
376
OBTAIN PRODUCT INFORMATION ON INSTALL SCRIPT
354
OBTAIN PRODUCT INFORMATION INSIDE MSI DATABASE
378
COMPARE INSTALL EXIT CODE WITH STANDARD EXE EXIT CODES
380
FIND PRODUCT NAME ON UNINSTALL REGISTRY KEY
356
COMPARE MSI PROPERTIES CONTENT WITH CONFIGURATION FILE
382
SUCCESS?
NO
YES
358
COMPARE INSTALL EXIT CODE WITH STANDARD MSI EXIT CODES
384
SEARCH FOR SIGNATURE FILE ON INSTALL SCRIPT
360
EXECUTE PRODUCT GUID CHECK
386
FIND SIGNATURE FILE ON THE SYSTEM
362
SUCCESS?
NO
364
END WITH UNSUCCESSFUL FLAG
374
END WITH SUCCESSFUL FLAG
YES
366
SEARCH FOR PRODUCT ON EVENT VIEWER
NO
368
SUCCESS?
YES
370
SEARCH FOR SIGNATURE FILE INSIDE MSI DATABASE
372
FIND SIGNATURE FILE ON THE SYSTEM

FIG. 3B

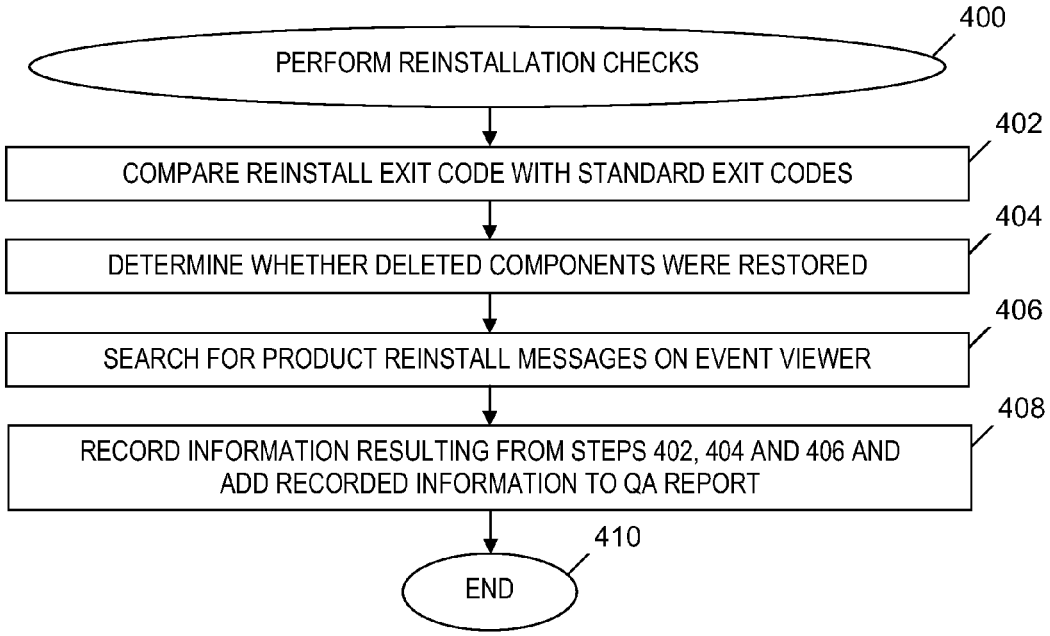
400
PERFORM REINSTALLATION CHECKS
402
COMPARE REINSTALL EXIT CODE WITH STANDARD EXIT CODES
404
DETERMINE WHETHER DELETED COMPONENTS WERE RESTORED
406
SEARCH FOR PRODUCT REINSTALL MESSAGES ON EVENT VIEWER
408
RECORD INFORMATION RESULTING FROM STEPS 402, 404 AND 406 AND ADD RECORDED INFORMATION TO QA REPORT
410
END

FIG. 4

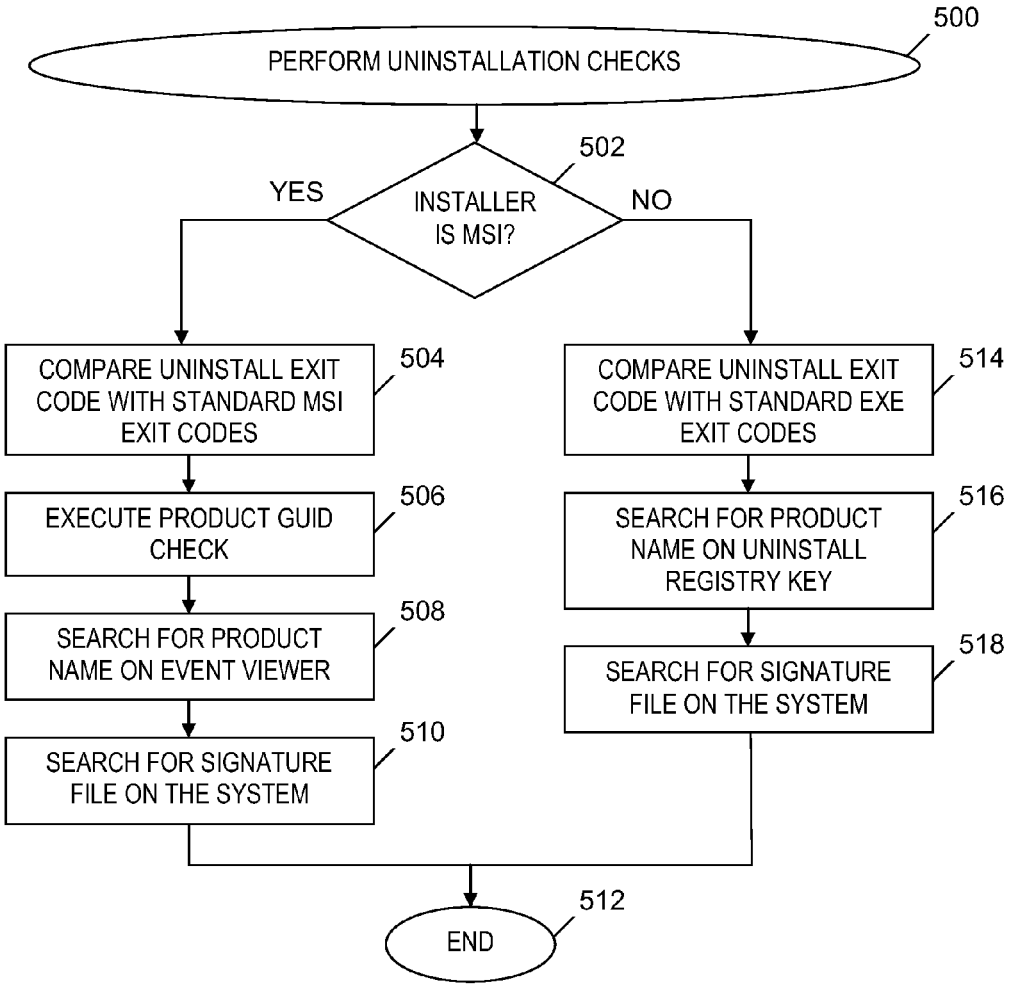
500
PERFORM UNINSTALLATION CHECKS
502
INSTALLER IS MSI?
YES
NO
504
COMPARE UNINSTALL EXIT CODE WITH STANDARD MSI EXIT CODES
506
EXECUTE PRODUCT GUID CHECK
508
SEARCH FOR PRODUCT NAME ON EVENT VIEWER
510
SEARCH FOR SIGNATURE FILE ON THE SYSTEM
514
COMPARE UNINSTALL EXIT CODE WITH STANDARD EXE EXIT CODES
516
SEARCH FOR PRODUCT NAME ON UNINSTALL REGISTRY KEY
518
SEARCH FOR SIGNATURE FILE ON THE SYSTEM
512
END

FIG. 5

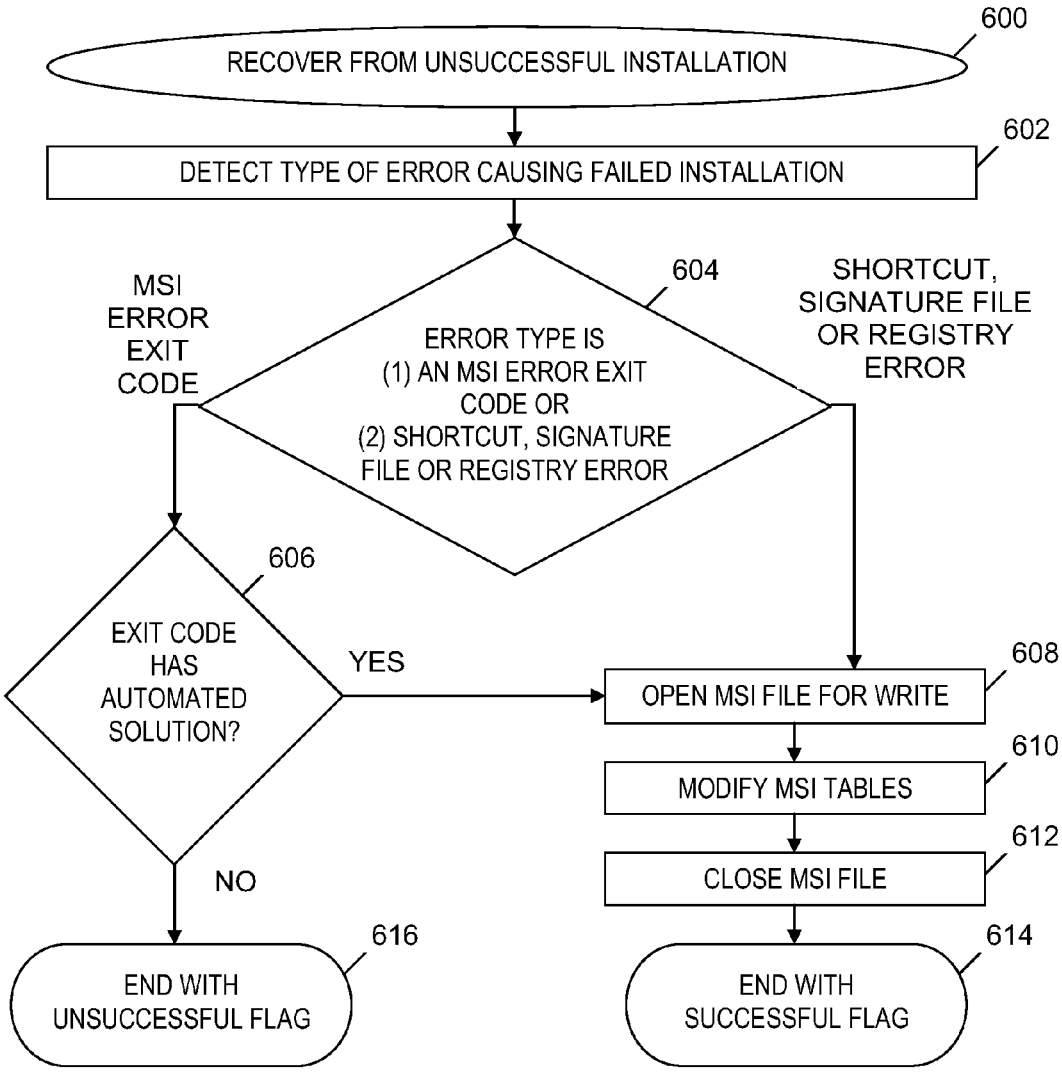
600
RECOVER FROM UNSUCCESSFUL INSTALLATION
602
DETECT TYPE OF ERROR CAUSING FAILED INSTALLATION
604
MSI ERROR EXIT CODE
ERROR TYPE IS (1) AN MSI ERROR EXIT CODE OR (2) SHORTCUT, SIGNATURE FILE OR REGISTRY ERROR
SHORTCUT, SIGNATURE FILE OR REGISTRY ERROR
606
EXIT CODE HAS AUTOMATED SOLUTION?
YES
NO
608
OPEN MSI FILE FOR WRITE
610
MODIFY MSI TABLES
612
CLOSE MSI FILE
614
END WITH SUCCESSFUL FLAG
616
END WITH UNSUCCESSFUL FLAG

FIG. 6

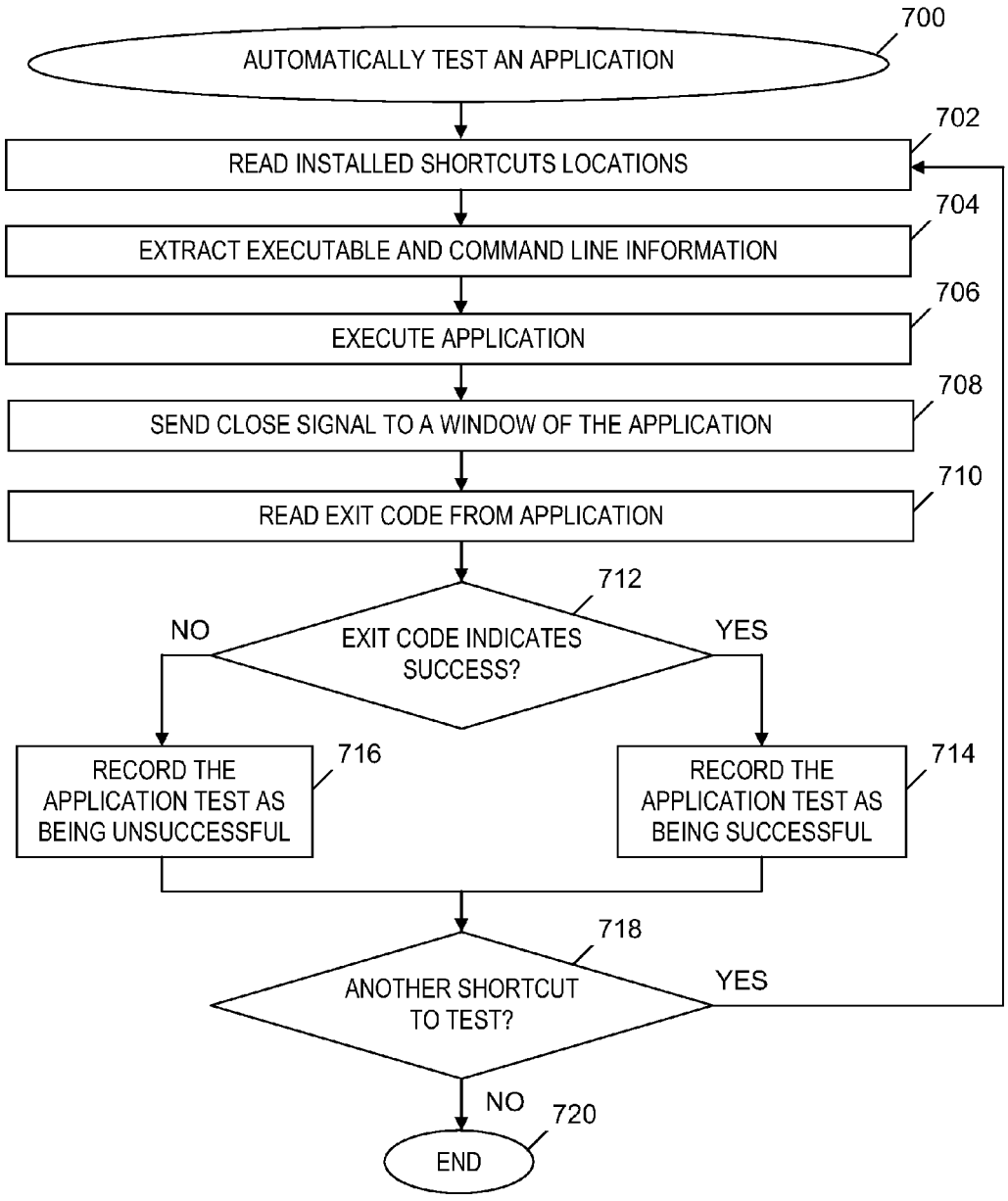
700
AUTOMATICALLY TEST AN APPLICATION
702
READ INSTALLED SHORTCUTS LOCATIONS
704
EXTRACT EXECUTABLE AND COMMAND LINE INFORMATION
706
EXECUTE APPLICATION
708
SEND CLOSE SIGNAL TO A WINDOW OF THE APPLICATION
710
READ EXIT CODE FROM APPLICATION
712
EXIT CODE INDICATES SUCCESS?
NO
YES
716
RECORD THE APPLICATION TEST AS BEING UNSUCCESSFUL
714
RECORD THE APPLICATION TEST AS BEING SUCCESSFUL
718
ANOTHER SHORTCUT TO TEST?
YES
NO
720
END

FIG. 7

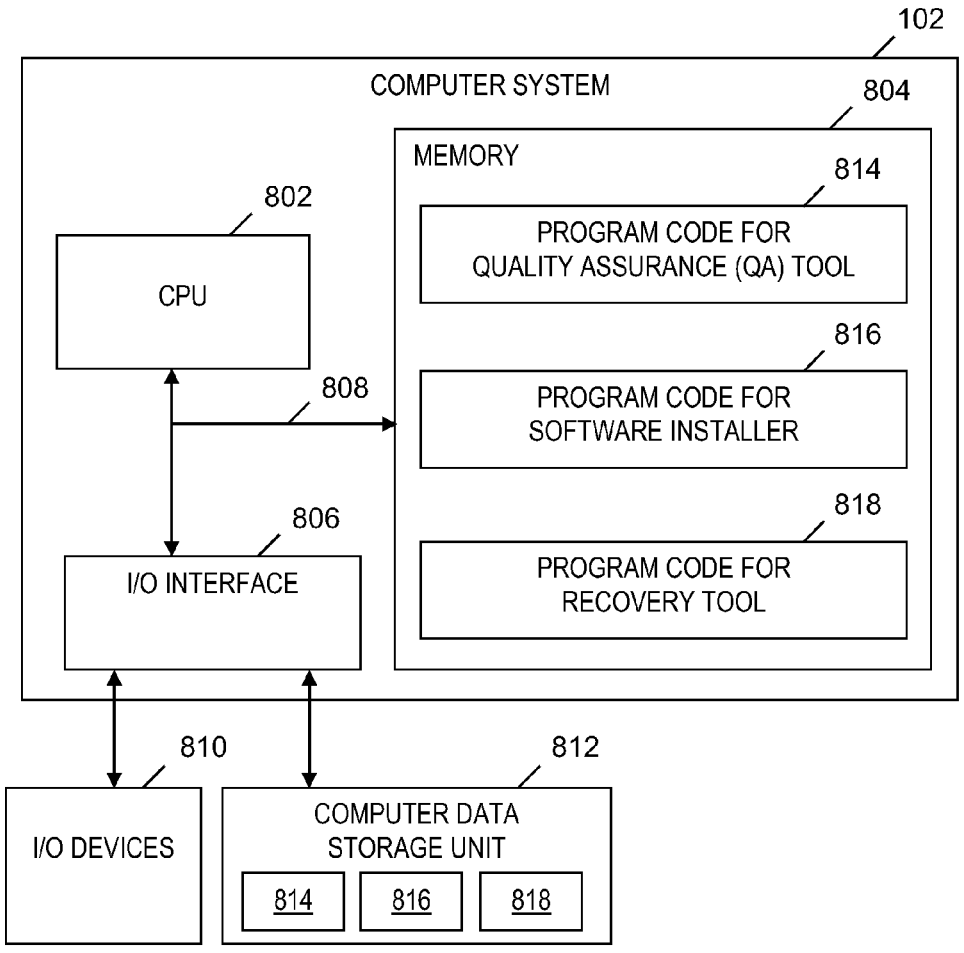
102
COMPUTER SYSTEM
804
MEMORY
814
802
PROGRAM CODE FOR
QUALITY ASSURANCE (QA) TOOL
CPU
816
808
PROGRAM CODE FOR
SOFTWARE INSTALLER
818
806
I/O INTERFACE
PROGRAM CODE FOR
RECOVERY TOOL
810
812
I/O DEVICES
COMPUTER DATA
STORAGE UNIT
814
816
818

FIG. 8

AUTOMATIC QUALITY ASSURANCE FOR SOFTWARE INSTALLERS

This application is a continuation application claiming priority to Ser. No. 13/826,961 filed Mar. 14, 2013, now U.S. Pat. No. 8,918,780, issued Dec. 23, 2014.

TECHNICAL FIELD

The present invention relates to a data processing method and system for assuring quality of software, and more particularly to a technique for automatically assuring quality of software installers.

BACKGROUND

An End User Services (EUS) Application Packaging service generates software installers (also known as (a.k.a.) "installation packages" or "packages"), based on customer requirements. Certain software applications, such as an Adobe® Reader® electronic document viewer, are configured and silently executed on customer's workstations to perform a transparent and unattended installation. The Adobe® Reader® electronic document viewer is offered by Adobe Systems, Inc. located in San Jose, Calif. In order to create installation packages, a standard and global "best practices" guide explains how to create a software installer using a standard set of tools. Different customers, however, demand different tools and methodologies when creating software installers. A quality assurance (QA) procedure for testing a software installer includes verifying that the software installer can provide successful installation, reinstallation and uninstallation of an application, and also includes several other checks. Log file generation and naming conventions, signed files or registry signed entries, and shortcut locations provide common verifications in the QA procedure. Packagers (i.e., people who create the software installers) manually perform the aforementioned verifications using a QA checklist as a guide. Because of the volume of packages being created, the packagers often do not use the QA checklist in the correct manner or the packagers do not have time to manually test each item, thereby leading to several required tests being omitted. The omitted tests lead to a package being delivered to a customer and failing, which results in the package being returned by the customer to be adjusted, thereby generating a significant number of rework incidents and a significant amount of time to modify the failures.

BRIEF SUMMARY

In a first embodiment, the present invention provides a method of managing a software installer. The method includes a computer recording information representative of a first view of an operating system of the computer. The method further includes the computer executing the software installer to create installed components in an installation of a software application. The method further includes subsequent to the step of executing the software installer to create the installed components in the installation, the computer recording information representative of a second view of the operating system. The method further includes the computer determining and recording a change between the first view and the second view. The method further includes based on the change, the computer recording information about the installed components. The method further includes the computer performing checks on the installation. The method further includes based on the checks on the installation, the computer determining whether the installation was successful. The method further includes responsive to a determination that the installation was successful, the computer removing selected installed components. The method further includes the computer executing the software installer to perform a reinstallation of the selected installed components that had been removed. The method further includes the computer performing checks on the reinstallation. The method further includes subsequent to the step of executing the software installer to perform the reinstallation, the computer recording information representative of a third view of the operating system. The method further includes the computer executing an uninstaller to perform an uninstallation of the software application. The method further includes subsequent to the step of executing the uninstaller, the computer recording information representative of a fourth view of the operating system. The method further includes the computer performing checks on the uninstallation. The method further includes the computer generating a report using the recorded information representative of the first, second, third and fourth views of the operating system.

In a second embodiment, the present invention provides a central processing unit (CPU); a memory coupled to the CPU; and a computer-readable, tangible storage device coupled to the CPU. The storage device includes instructions that are executed by the CPU via the memory to implement a method of managing a software installer. The method includes the computer system recording information representative of a first view of an operating system of the computer system. The method further includes the computer system executing the software installer to create installed components in an installation of a software application. The method further includes subsequent to the step of executing the software installer to create the installed components in the installation, the computer system recording information representative of a second view of the operating system. The method further includes the computer system determining and recording a change between the first view and the second view. The method further includes based on the change, the computer system recording information about the installed components. The method further includes the computer system performing checks on the installation. The method further includes based on the checks on the installation, the computer system determining whether the installation was successful. The method further includes responsive to a determination that the installation was successful, the computer system removing selected installed components. The method further includes the computer system executing the software installer to perform a reinstallation of the selected installed components that had been removed. The method further includes the computer system performing checks on the reinstallation. The method further includes subsequent to the step of executing the software installer to perform the reinstallation, the computer system recording information representative of a third view of the operating system. The method further includes the computer system executing an uninstaller to perform an uninstallation of the software application. The method further includes subsequent to the step of executing the uninstaller, the computer system recording information representative of a fourth view of the operating system. The method further includes the computer system performing checks on the uninstallation. The method further includes the computer system generating a report using the recorded information representative of the first, second, third and fourth views of the operating system.

In a third embodiment, the present invention provides a computer program product including a computer-readable,

tangible storage device and a computer-readable program code stored in the computer-readable, tangible storage device. The computer-readable program code includes instructions that are executed by a central processing unit (CPU) of a computer system to implement a method of managing a software installer. The method includes the computer system recording information representative of a first view of an operating system of the computer system. The method further includes the computer system executing the software installer to create installed components in an installation of a software application. The method further includes subsequent to the step of executing the software installer to create the installed components in the installation, the computer system recording information representative of a second view of the operating system. The method further includes the computer system determining and recording a change between the first view and the second view. The method further includes based on the change, the computer system recording information about the installed components. The method further includes the computer system performing checks on the installation. The method further includes based on the checks on the installation, the computer system determining whether the installation was successful. The method further includes responsive to a determination that the installation was successful, the computer system removing selected installed components. The method further includes the computer system executing the software installer to perform a reinstallation of the selected installed components that had been removed. The method further includes the computer system performing checks on the reinstallation. The method further includes subsequent to the step of executing the software installer to perform the reinstallation, the computer system recording information representative of a third view of the operating system. The method further includes the computer system executing an uninstaller to perform an uninstallation of the software application. The method further includes subsequent to the step of executing the uninstaller, the computer system recording information representative of a fourth view of the operating system. The method further includes the computer system performing checks on the uninstallation. The method further includes the computer system generating a report using the recorded information representative of the first, second, third and fourth views of the operating system.

In a fourth embodiment, the present invention provides a process for supporting computing infrastructure. The process includes a first computer system providing at least one support service for at least one of creating, integrating, hosting, maintaining, and deploying computer-readable code in a second computer system. The computer-readable code includes instructions, where the instructions, when executed by a processor of the second computer system, implement a method of managing a software installer. The method includes the second computer system recording information representative of a first view of an operating system of the second computer system. The method further includes the second computer system executing the software installer to create installed components in an installation of a software application. The method further includes subsequent to the step of executing the software installer to create the installed components in the installation, the second computer system recording information representative of a second view of the operating system. The method further includes the second computer system determining and recording a change between the first view and the second view. The method further includes based on the change, the second computer system recording information about the installed components. The method further includes the second computer system performing checks on the installation. The method further includes based on the checks on the installation, the second computer system determining whether the installation was successful. The method further includes responsive to a determination that the installation was successful, the second computer system removing selected installed components. The method further includes the second computer system executing the software installer to perform a reinstallation of the selected installed components that had been removed. The method further includes the second computer system performing checks on the reinstallation. The method further includes subsequent to the step of executing the software installer to perform the reinstallation, the second computer system recording information representative of a third view of the operating system. The method further includes the second computer system executing an uninstaller to perform an uninstallation of the software application. The method further includes subsequent to the step of executing the uninstaller, the second computer system recording information representative of a fourth view of the operating system. The method further includes the second computer system performing checks on the uninstallation. The method further includes the second computer system generating a report using the recorded information representative of the first, second, third and fourth views of the operating system.

Embodiments of the present invention provide an automated technique for verifying software installers, thereby reducing rework incidents, avoiding common human errors and forcing packagers to perform the correct verifications. Embodiments of the present invention generate detailed reports on the behavior of a software installer and verification tests performed on the software installer. The reports can be shared among teams involved in an application packaging tasks cycle. Packagers viewing the generated report learn from their errors because they view detected problems as the problems occur.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a system for assuring quality of a software installer, in accordance with embodiments of the present invention.

FIGS. **2**A-**2**B depict a flowchart of a process of assuring quality of a software installer in the system of FIG. **1**, in accordance with embodiments of the present invention.

FIG. **3**A is a flowchart of a process of performing installation checks in the process of FIGS. **2**A-**2**B, in accordance with embodiments of the present invention.

FIG. **3**B is a flowchart of a process of verifying software installation in the process of FIG. **3**A, in accordance with embodiments of the present invention.

FIG. **4** is a flowchart of a process of performing reinstallation checks in the process of FIGS. **2**A-**2**B, in accordance with embodiments of the present invention.

FIG. **5** is a flowchart of a process of performing uninstallation checks in the process of FIGS. **2**A-**2**B, in accordance with embodiments of the present invention.

FIG. **6** is a flowchart of a process of recovering from an unsuccessful installation determined in the process of FIGS. **2**A-**2**B, in accordance with embodiments of the present invention.

FIG. **7** is a flowchart of a sub-process of automatically testing an application, which is included in the process of FIG. **3**A, in accordance with embodiments of the present invention.

FIG. **8** is a block diagram of a computer system included in the system of FIG. **1** and that implements the processes of FIGS. **2**A-**2**B, FIG. **3**A, FIG. **3**B, FIG. **4**, FIG. **5**, FIG. **6**, and FIG. **7**, in accordance with embodiments of the present invention.

DETAILED DESCRIPTION

Overview

Embodiments of the present invention automatically perform quality assurance testing on features of software installers, including installation, reinstallation and uninstallation of a software application. Embodiments of the present invention take operating system snapshots (i.e., captures) before and after installation and before and after uninstallation to verify the installation and uninstallation, respectively. A selection of installed files resulting from the installation may be deleted to verify reinstallation. In one embodiment, a final quality assurance report is generated based on all information collected when verifying installation, reinstallation, and uninstallation. The final report may include the installed, modified and erased files resulting from the installation, reinstallation and uninstallation.

System for Assuring Quality of a Software Installer

FIG. **1** is a block diagram of a system for assuring quality of a software installer, in accordance with embodiments of the present invention. A system **100** includes a computer system **102**, which runs a software-based quality assurance (QA) tool **104** and a software installer **106**. QA tool **104** includes an operating system (O/S) snapshot generator, an O/S snapshot comparison analyzer **110**, an installation checks tool **112**, a reinstallation checks tool **114**, an uninstallation checks tool **116**, and a QA report generator **118**. Computer system **102** includes other components which are shown in FIG. **8** and described in the discussion of FIG. **8**, presented below.

System **100** also includes a data repository **120**, which is operatively coupled to computer system **102**. Data repository **120** includes a configuration file **122**, O/S snapshots **124** and a database **126**. QA tool **104** reads configuration file **122**. O/S snapshot generator **108** generates O/S snapshots **124**. O/S snapshot comparison analyzer **110** receives and compares O/S snapshots **124** taken before and after an installation of software installer **106** and before and after an uninstallation of software installer **106**. From the comparisons, O/S snapshot comparison analyzer determines installed, modified and deleted files and shortcut(s) stores the files and shortcut(s) in database **126**.

Installation checks tool **112** performs verification checks on an installation of a software application performed by software installer **106**. Reinstallation checks tool **114** performs verification checks on a reinstallation of the software application by software installer **106**. As used herein, a reinstallation includes reinstalling, not an entire software application, but only the files or other components that are required for a complete installation but are currently missing (e.g., files that had been previously deleted due to, for example, a deletion of shortcuts by a user or a deletion of files by malware). By reinstalling only the files or other components that are currently missing, a reinstallation avoids a need to uninstall an entire software application and then installing the entire software application again. Uninstallation checks tool **116** performs verification checks on an uninstallation of the software application by software installer **106** or by a software-based uninstaller (not shown) associated with software installer **106**. Hereinafter, the software application whose installation is verified by installation checks tool **112**, whose reinstallation is verified by reinstallation checks tool **114**, and/or whose uninstallation is verified by uninstallation checks tool **116** is also referred to simply as "the software application."

QA report generator **118** generates a final QA report **128** based on information collected when verifying the installation, reinstallation, and uninstallation of the software application. In one embodiment, QA report **128** indicates files that are installed, files that are modified and/or files that are deleted as a result of the installation, reinstallation and uninstallation verifications.

Computer system **102** also runs a software-based recovery tool **130**, which is invoked in response to determining that an installation fails. Recovery tool **130** attempts to fix a software installer based on information collected as a result of the installation verification.

The functionality of the components of FIG. **1** is described in more detail in the discussions presented below relative to FIGS. **2**A-**2**B, FIG. **3**A, FIG. **3**B, FIG. **4**, FIG. **5**, FIG. **6**, and FIG. **7**, and in the section entitled Computer System.

Processes for Assuring Quality of an Installation by a Software Installer

FIGS. **2**A-**2**B depict a flowchart of a process of assuring quality of a software installer in the system of FIG. **1**, in accordance with embodiments of the present invention. The process of FIGS. **2**A-**2**B begins at step **200**. In step **202**, QA tool **104** (see FIG. **1**) reads configuration file **122** (see FIG. **1**).

In step **204**, QA tool **104** (see FIG. **1**) receives a selection of software installer **106** (see FIG. **1**).

In step **206**, O/S snapshot generator **108** (see FIG. **1**) generates a first snapshot of an O/S of computer system **102** (see FIG. **1**) and stores the first snapshot in O/S snapshots **124** (see FIG. **1**) included in data repository **120** (see FIG. **1**).

In step **208**, QA tool **104** (see FIG. **1**) initiates an execution of software installer **106** (see FIG. **1**) to perform an installation of a software application, and subsequently determines that the installation is finished.

In step **210**, O/S snapshot generator **108** (see FIG. **1**) generates a second snapshot of the O/S of computer system **102** (see FIG. **1**) and stores the second snapshot in O/S snapshots **124** (see FIG. **1**) included in data repository **120** (see FIG. **1**).

In step **212**, O/S snapshot comparison analyzer compares the aforementioned first and second snapshots generated in steps **206** and **210**, respectively. Using the result of the comparison of the first and second snapshots, O/S snapshot comparison analyzer **110** (see FIG. **1**) determines changes resulting from the installation that finished in step **208**. The aforementioned changes include components that were installed (i.e., the installed components), other components that were modified, and/or still other components that were deleted as a result of the installation that finished in step **208**. The aforementioned components include installed, modified and deleted computer files and shortcut(s) to the software application whose installation was finished in step **208**. O/S snapshot comparison analyzer **110** (see FIG. **1**) stores the changes in database **126** (see FIG. **1**) in data repository **120** (see FIG. **1**). In one embodiment, the changes determined in step **212** are indicated by timestamp differences between the first and second snapshots.

In step **214**, installation checks tool **112** (see FIG. **1**) performs verification checks on the installation of the software application that finished in step **208**. The verification checks on the installation are described below relative to FIG. **3**A and FIG. **3**B.

In step **216**, QA tool **104** (see FIG. **1**) determines whether the installation finished in step **208** was successful based on the installation checks performed in step **214**. If QA tool **104**

(see FIG. **1**) determines in step **216** that the installation was successful, then the Yes branch of step **216** is taken and step **218** is performed.

In step **218**, QA tool **104** (see FIG. **1**) determines that a proper subset of the installed components (a.k.a. the selected installed components) determined and stored in step **212** are to be deleted, and subsequently deletes the selected installed components from database **126** (see FIG. **1**). The selected installed components may include shortcuts that software installer **106** (see FIG. **1**) runs, or particular files found on a data table generated by an MSI installer, or particular files identified by the comparison in step **212** if the software installer is an EXE installer. MSI installers and EXE installers are described below in the discussion of FIG. **3**B.

In step **220**, QA tool **104** (see FIG. **1**) initiates a re-execution of software installer **106** (see FIG. **1**) to perform a reinstallation of the software application, and subsequently determines that the reinstallation of the software application is finished.

In step **222**, reinstallation checks tool **114** (see FIG. **1**) performs verification checks on the reinstallation of the software application that finished in step **220**. The verification checks on the reinstallation are described below relative to FIG. **4**.

Following step **222**, the process of FIGS. **2**A-**2**B continues with step **224** in FIG. **2**B. In step **224**, O/S snapshot generator **108** (see FIG. **1**) generates a third snapshot of the O/S and stores the third snapshot in O/S snapshots **124** (see FIG. **1**) included in data repository **120** (see FIG. **1**).

In step **226**, QA tool **104** (see FIG. **1**) initiates an execution of software installer **106** (see FIG. **1**) or an uninstaller running on computer system **102** (see FIG. **1**) to perform an uninstallation of the software application, and subsequently determines that the uninstallation is finished.

In step **228**, O/S snapshot generator **108** (see FIG. **1**) generates a fourth snapshot of the O/S and stores the fourth snapshot in O/S snapshots **124** (see FIG. **1**) included in data repository **120** (see FIG. **1**).

In step **230**, uninstallation checks tool **116** (see FIG. **1**) performs verification checks on the uninstallation of the software application that finished in step **226**. The verification checks on the uninstallation are described below relative to FIG. **5**.

In step **232**, QA report generator **118** (see FIG. **1**) generates QA report **128** (see FIG. **1**). Following step **232**, the process of FIGS. **2**A-**2**B ends at step **234**.

Returning to step **216** (see FIG. **2**A), if QA tool **104** (see FIG. **1**) determines that the installation was unsuccessful, then the No branch of step **216** (see FIG. **2**A) is taken and step **236** is performed. In step **236**, QA report generator **118** (see FIG. **1**) generates QA report **128** (see FIG. **1**). If software installer **106** (see FIG. **1**) is an MSI installer, then step **238** follows step **236**. In step **238**, recovery tool **130** (see FIG. **1**) automatically recovers from the unsuccessful (i.e., failed) installation. In one embodiment, step **238** includes the steps of the process of FIG. **6**. Following step **238**, the process of FIGS. **2**A-**2**B ends at step **234**. If software installer **106** (see FIG. **1**) is an EXE installer, then following step **236**, there is an optional manual recovery from the unsuccessful installation, and subsequently the process of FIGS. **2**A-**2**B ends at step **234**.

In one embodiment, the checks performed in steps **214** and **222** in FIG. **2**A and step **230** in FIG. **2**B include generating a specially designed semaphore on a display to visually indicate by different colors or other graphical elements the results of the checks. For example, the semaphore may show red to indicate the installation by software installer **106** (see FIG. **1**) was unsuccessful.

FIG. **3**A is a flowchart of a process of performing installation checks in the process of FIGS. **2**A-**2**B, in accordance with embodiments of the present invention. In one embodiment, step **214** (see FIG. **2**A) includes the process of FIG. **3**A. The process of FIG. **3**A begins at step **300**. In step **302**, installation checks tool **112** (see FIG. **1**) verifies the installation of the software application based on whether the computer file of software installer **106** (see FIG. **1**) has an .msi file extension or an .exe file extension. Step **302** includes the steps of FIG. **3**B, described below. The result of step **302** is installation checks tool **112** (see FIG. **1**) assigning a first value to a flag to indicate that the installation was successful or assigning a second value to a flag to indicate that the installation was unsuccessful. An .msi file extension indicates the computer file is a Microsoft® software installer offered by Microsoft Corporation located in Redmond, Wash. The software installer having an .msi file extension is used for installing Microsoft® Windows® software offered by Microsoft Corporation. Although the present invention discusses a computer file (in the singular) of software installer **106** (see FIG. **1**), those skilled in the art will appreciate that the software installer may also include one or more other files that are used by the file having the .msi or .exe file name extension.

In step **304**, installation checks tool **112** (see FIG. **1**) determines whether the installation of the software application was successful based on whether the aforementioned flag has the first value (i.e., a successful flag indicating the installation was successful) or the second value (i.e., an unsuccessful flag indicating the installation was unsuccessful). If installation checks tool **112** (see FIG. **1**) determines in step **304** that the installation of the software application was unsuccessful, then the No branch of step **304** is taken and the process of FIG. **3**A ends with installation checks tool **112** (see FIG. **1**) assigning a value to a flag to indicate the unsuccessful installation. If installation checks tool **112** (see FIG. **1**) determines in step **304** that the installation of the software application was successful, then the Yes branch of step **304** is taken and step **308** is performed.

In step **308**, installation checks tool **112** (see FIG. **1**) searches for any shortcuts in the installation changes in database **126** included in data repository **120** (see FIG. **1**). The installation changes were written to database **126** in step **212** (see FIG. **2**A). In one embodiment, the changes written to database **126** in step **212** (see FIG. **2**A) include one or more shortcuts to the software application.

In step **310**, installation checks tool **112** (see FIG. **1**) determines from the search in step **308** whether shortcut(s) were found in the database included in data repository **120** (see FIG. **1**). If installation checks tool **112** (see FIG. **1**) determines shortcut(s) were found in the search performed in step **308**, then the Yes branch of step **310** is taken and step **312** is performed.

In step **312**, installation checks tool **112** (see FIG. **1**) determines path(s) of the found shortcut(s) and compares the path(s) of the shortcut(s) with path(s) of shortcut(s) in configuration file **122** (see FIG. **1**). The path(s) in configuration file **122** (see FIG. **1**) are the path(s) of shortcut(s) expected to exist after a successful installation of the software application. Also in step **312**, installation checks tool **112** (see FIG. **1**) writes the determined path(s) of shortcut(s) into QA report **128** (see FIG. **1**).

In step **314**, installation checks tool **112** (see FIG. **1**) writes to data repository **120** (see FIG. **1**) location(s) of the shortcut(s) found as a result of the search in step **308**.

In step **316**, installation checks tool **112** (see FIG. **1**) initiates an execution of the shortcut(s) found as a result of the search in step **308**. In one embodiment, shortcuts are executed in step **316** one by one, and with each execution, a human operator determines whether the shortcut being executed and the software application being launched by the shortcut are working properly.

In step **318**, installation checks tool **112** (see FIG. **1**) records in data repository **120** (see FIG. **1**) the results of the execution initiated in step **316**, where the recorded results are included in QA report **128** (see FIG. **1**). The results recorded in step **318** may include the operator's determination whether each shortcut and the software application are working properly.

In step **320**, the process of FIG. **3**A ends with installation checks tool **112** (see FIG. **1**) assigning a value to a flag to indicate the installation was successful.

Returning to step **310**, if installation checks tool **112** (see FIG. **1**) determines that no shortcut was found as a result of the search in step **308**, then the No branch of step **310** is taken, and the process of FIG. **3**A ends at step **320**, with installation checks tool **112** (see FIG. **1**) assigning a value to a flag to indicate the installation was successful.

FIG. **3**B is a flowchart of a process of verifying software installation in the process of FIG. **3**A, in accordance with embodiments of the present invention. In one embodiment, step **302** (see FIG. **3**A) includes the process of FIG. **3**B. The process of FIG. **3**B starts at step **350**. In step **352**, installation checks tool **112** (see FIG. **1**) determines whether software installer **106** (see FIG. **1**) is an MSI installer (i.e., the computer file of software installer **106** (see FIG. **1**) has an .msi file extension) or an EXE installer (i.e., the computer file of the software installer has an .exe file extension). If installation checks tool **112** (see FIG. **1**) determines in step **352** that software installer **106** (see FIG. **1**) is an MSI installer, then the Yes branch of step **352** is taken and step **354** is performed.

In step **354**, installation checks tool **112** (see FIG. **1**) obtains product information (i.e., information about the software application whose installation by software installer **106** (see FIG. **1**) is being verified) by opening a database (i.e., MSI database) resulting from software installer **106** (see FIG. **1**) installing the software application in step **208** (see FIG. **2**A), and reading and collecting information from the opened database about the software application whose installation is being verified. In one embodiment, the MSI database is included in data repository **120** (see FIG. **1**). The collected information includes a product code and a product name identifying the software application, and further includes properties (i.e., MSI properties) and computer files needed for verification of the installation of the software application. In one embodiment, step **354** also includes installation checks tool **112** (see FIG. **1**) recording the aforementioned collected information in data repository **120** (see FIG. **1**) and QA report generator **118** (see FIG. **1**) including the recorded information in QA report **128** (see FIG. **1**).

In step **356**, installation checks tool **112** (see FIG. **1**) compares the MSI properties collected in step **354** with properties in configuration file **122** (see FIG. **1**) to determine whether the MSI properties match the properties in configuration file **122** (see FIG. **1**) (i.e., match the expected properties of an MSI installer). For example, the properties included in the collected information may include a first indicator that software installer **106** (see FIG. **1**) is to be installed for all users of computer system **102** (see FIG. **1**), or a second indicator that software installer **106** (see FIG. **1**) is to be installed for only one particular user. In one embodiment, step **356** also includes installation checks tool **112** (see FIG. **1**) recording the result of the comparison in step **356** in data repository **120** (see FIG. **1**) and QA report generator **118** (see FIG. **1**) including the recorded result in QA report **128** (see FIG. **1**).

In step **358**, installation checks tool **112** (see FIG. **1**) compares an exit code returned from the installation that finishes in step **208** (see FIG. **2**A) with standard MSI exit codes that can result from executing an MSI installer (i.e., Microsoft® Standard Exit Codes provided by Microsoft Corporation) and determines which of the standard MSI exit codes matches the exit code returned from the installation. The comparison performed in step **358** retrieves the standard exit codes from data repository **120** (see FIG. **1**). In one embodiment, the standard exit codes includes an exit code of "0" which indicates that the installation was successful. In one embodiment, step **358** also includes installation checks tool **112** (see FIG. **1**) recording the result of the aforementioned exit code comparison in data repository **120** (see FIG. **1**) and QA report generator **118** (see FIG. **1**) adding the recorded result to QA report **128** (see FIG. **1**).

As used herein, an exit code is a code returned by software installer **106** (see FIG. **1**) installing, reinstalling or uninstalling the software application, where the code indicates the installation, reinstallation or uninstallation was completed successfully or indicates a particular error that occurred to make the installation, reinstallation or uninstallation unsuccessful. For example, a software installer that is installing a software suite S needs Application A to be installed. The software installer verifies if Application A is installed. If the software installer determines Application A is not installed, then the exit code matches error code "100." A standard error code list includes error code **100** and its meaning that Application A is needed for the installation of software suite S, but that Application A is not installed.

In step **360**, installation checks tool **112** (see FIG. **1**) executes a product globally unique identifier (product GUID) check. A product GUID is a unique reference number that identifies the software application whose installation is being verified in the process of FIG. **3**B. A product GUID check includes installation checks tool **112** (see FIG. **1**) determining whether the product code collected in step **354** matches a code specifying the software application, where the code is retrieved from a system dynamic-link library (DLL) file or registry of computer system **102** (see FIG. **1**). If the product code matches the retrieved code, then the product GUID check indicates a successful installation. In one embodiment, step **360** also includes installation checks tool **112** (see FIG. **1**) recording the result of the product GUID check in data repository **120** (see FIG. **1**) and QA report generator **118** (see FIG. **1**) including the recorded result in QA report **128** (see FIG. **1**).

In step **362**, installation checks tool **112** (see FIG. **1**) determines whether the installation of the software application that finished in step **208** (see FIG. **2**A) is successful based on the results of steps **356**, **358** and **360**. If the comparison in step **356** determines that the MSI properties does not match the properties in configuration file **122** (see FIG. **1**), the comparison in step **358** determines that the exit code returned from the installation does not match a standard MSI exit code indicating a successful installation, or the product GUID check in step **360** determines that the product code collected in step **354** does not match a code of the software application retrieved from a DLL file of computer system **102** (see FIG. **1**), then in step **362**, installation checks tool **112** (see FIG. **1**) determines that the installation of the software application is unsuccessful, the No branch of step **362** is taken, and the process of FIG. **3**B ends at step **364**, with installation checks

tool **112** (see FIG. **1**) assigning a value to a flag indicating that the installation was unsuccessful.

If the comparison in step **356** determines that the MSI properties match the properties in configuration file **122** (see FIG. **1**), the comparison in step **358** determines that the exit code returned from the installation matches a standard MSI exit code indicating a successful installation, and the product GUID check in step **360** determines that the product code collected in step **354** matches a code of the software application retrieved from a DLL file of computer system **102** (see FIG. **1**), then in step **362**, installation checks tool **112** (see FIG. **1**) determines that the installation of the software application is a success, the Yes branch of step **362** is taken, and step **366** is performed.

In step **366**, installation checks tool **112** (see FIG. **1**) searches for the product name collected in step **354**, where the search is done on log files maintained by an event viewer of the operating system of computer system **102** (see FIG. **1**). The log files store all the events occurring on the operating system of computer system **102** (see FIG. **1**). The events included in the log files include an installation of the software application or software installer **106** (see FIG. **1**), and includes text indicating whether the installation was successful. The search in step **366** also includes a search of the log files of the event viewer for particular text that indicates the installation is successful or for other text that indicates the installation is unsuccessful. Installation checks tool **112** (see FIG. **1**) determines the installation was successful if the search in step **366** finds the product name in the log files and finds the particular text that indicates a successful installation.

In step **368**, installation checks tool **112** (see FIG. **1**) determines whether the installation of the software application is a success by determining whether the search in step **366** finds an error in the product name. If installation checks tool **112** (see FIG. **1**) in step **368** determines that no error was found in the search performed in step **366**, then the Yes branch is taken and step **370** is performed.

In step **370**, installation checks tool **112** (see FIG. **1**) searches inside the aforementioned MSI database and finds a signature file (a.k.a. sign file or signed file) included in configuration file **122** (see FIG. **1**). In one embodiment, step **370** also includes installation checks tool **112** (see FIG. **1**) recording the result of the search for the signature file in data repository **120** (see FIG. **1**) and QA report generator **118** (see FIG. **1**) including the recorded result in QA report **128** (see FIG. **1**). A signature file is used to keep track of what computer systems have received a software distribution.

In step **372**, installation checks tool **112** (see FIG. **1**) determines that the signature file found in step **370** matches a signature file included in the second snapshot generated in step **210** (see FIG. **2**A). The match determined in step **372** ensures that the signature file was installed by the installation that finished in step **208** (see FIG. **2**A).

Based on the match in step **372** ensuring that the signature file found in step **370** was installed, installation checks tool **112** (see FIG. **1**) assigns a value to a flag to indicate that the installation of the software application was successful and the process of FIG. **3**B ends at step **374**.

Returning to step **368**, if installation checks tool **112** (see FIG. **1**) determines that the installation of the software application is unsuccessful by determining the search in step **366** finds an error in the product name, then the No branch of step **368** is taken and the process of FIG. **3**B ends at step **364**, with installation checks tool **112** (see FIG. **1**) assigning a value to a flag to indicate the installation of the software application was unsuccessful.

Returning to step **352**, if installation checks tool **112** (see FIG. **1**) determines software installer **106** (see FIG. **1**) is an EXE installer, then the No branch of step **352** is taken and step **376** is performed.

In step **376**, installation checks tool **112** (see FIG. **1**) extracts product information from a developer's install script or source code for installing the software application. The product information includes the product name identifying the software application. In one embodiment, a script analyzer (not shown in FIG. **1**) extracts the aforementioned product information in step **376**.

In step **378**, installation checks tool **112** (see FIG. **1**) reads an exit code returned from the installation that finished in step **208** (see FIG. **2**A) and compares the returned exit code with exit codes on a standard exit code list that was used for the type of software installer **106** (see FIG. **1**) that was determined in step **352** (i.e., an EXE installer). The standard exit code list is created by a developer of the EXE installer and stored in data repository **120** (see FIG. **1**). In one embodiment, an exit code of "0" indicates that the installation was successful. In one embodiment, step **378** also includes installation checks tool **112** (see FIG. **1**) recording the result of the exit code comparison in step **378** in data repository **120** (see FIG. **1**) and QA report generator **118** (see FIG. **1**) including the recorded result in QA report **128** (see FIG. **1**).

In step **380**, installation checks tool **112** (see FIG. **1**) searches for and finds a product name on an uninstall registry key. Finding a remove button in the uninstall registry that corresponds to the product name means that the installation successfully finished all of its tasks because creating the remove button on the uninstall registry is the last action performed by an EXE installer.

In step **382**, installation checks tool **112** (see FIG. **1**) determines whether the installation is a success based on whether the comparison in step **378** determines the returned exit code matches a standard exit code from the standard exit code list, and based on whether the product name found in step **380** matches the product name extracted in step **376**.

If installation checks tool **112** (see FIG. **1**) determines in step **382** that the returned exit code matches a standard exit code and the product name found in step **380** matches the product name extracted in step **376**, then installation checks tool **112** (see FIG. **1**) determines the installation is a success, the Yes branch of step **382** is taken and step **384** is performed.

In step **384**, installation checks tool **112** (see FIG. **1**) searches for and extracts a location of a signature file on the aforementioned install script or installation source code. Subsequently, installation checks tool **112** (see FIG. **1**) retrieves the signature file whose location was extracted in step **384**. In one embodiment, step **384** also includes installation checks tool **112** (see FIG. **1**) recording the result of the search for the location of the signature file in data repository **120** (see FIG. **1**) and QA report generator **118** (see FIG. **1**) including the recorded result in QA report **128** (see FIG. **1**).

In step **386**, installation checks tool **112** (see FIG. **1**) finds a signature file in the second snapshot of the O/S generated in step **210** (see FIG. **2**A). Following step **386**, installation checks tool **112** (see FIG. **1**) determines the signature file whose location was extracted in step **384** matches the signature in the second snapshot generated in step **210** (see FIG. **2**A). Based on the aforementioned match of the signature files, installation checks tool **112** (see FIG. **1**) determines the installation was successful and assigns a value to a flag indicating the installation was successful. Following step **386**, the process of FIG. **3**B ends at step **374**.

Returning to step **382**, if installation checks tool **112** (see FIG. **1**) determines that the returned exit code does not match

a standard exit code that indicates a successful installation or the product name found in step **380** does not match the product name extracted in step **376**, then installation checks tool **112** (see FIG. **1**) determines the installation is unsuccessful, the No branch of step **382** is taken and the process of FIG. **3**B ends at step **364**, with installation checks tool **112** (see FIG. **1**) assigning a value to a flag indicating that the installation was unsuccessful.

Process for Assuring Quality of a Reinstallation by a Software Installer

FIG. **4** is a flowchart of a process of performing reinstallation checks in the process of FIGS. **2**A-**2**B, in accordance with embodiments of the present invention. In one embodiment, step **222** (see FIG. **2**A) includes the process of FIG. **4**. The process of FIG. **4** starts at step **400**. In step **402**, reinstallation checks tool **114** (see FIG. **1**) reads the exit code returned from the reinstallation finished in step **220** (see FIG. **2**A) and compares the returned exit code with standard exit codes. The standard exit codes are standard MSI exit codes if step **352** (see FIG. **3**B) determines that software installer **106** (see FIG. **1**) is an MSI installer or are standard EXE exit codes if step **352** (see FIG. **3**B) determines that software installer **106** (see FIG. **1**) is an EXE installer. The comparison performed in step **402** retrieves the standard exit codes from data repository **120** (see FIG. **1**).

In step **404**, reinstallation checks tool **114** (see FIG. **1**) reads database **126** (see FIG. **1**) to search for and find previously installed components that were deleted in step **218** (see FIG. **2**A), and subsequently determines whether the installed components that had been deleted in step **218** (see FIG. **1**) were restored by the reinstallation that was finished in step **220** (see FIG. **2**A). Determining the previously deleted components were restored includes determining the previously deleted components are present in computer system **102** (see FIG. **1**).

In step **406**, reinstallation checks tool **114** (see FIG. **1**) searches for any message in the event viewer of the O/S of computer system **102** (see FIG. **1**) that includes the product name of the software application reinstalled by the reinstallation that finished in step **220** (see FIG. **2**A).

In step **408**, reinstallation checks tool **114** (see FIG. **1**) records the information resulting from steps **402**, **404** and **406** in data repository **120** (see FIG. **1**), and subsequently, QA report generator **118** (see FIG. **1**) retrieves the recorded information resulting from steps **402**, **404** and **406** to include in QA report **128** (see FIG. **1**).

Although not shown, reinstallation checks tool **114** (see FIG. **1**) determines that the reinstallation that finished in step **220** was successful if the comparison in step **402** results in the returned exit code matching one of the standard exit codes, all the components deleted in step **218** (see FIG. **2**A) are determined in step **404** to be restored, and the product name is found in the event viewer messages in step **406**. Reinstallation checks tool **114** (see FIG. **1**) determines that the reinstallation that finished in step **220** was unsuccessful if the comparison in step **402** results in the returned exit code not matching any of the standard exit codes, not all of the components deleted in step **218** (see FIG. **2**A) are determined in step **404** to be restored, or the product name is not found in any event viewer message in step **406**.

Following step **408**, the process of FIG. **4** ends at step **410**.

Process for Assuring Quality of an Uninstallation by a Software Installer

FIG. **5** is a flowchart of a process of performing uninstallation checks in the process of FIGS. **2**A-**2**B, in accordance with embodiments of the present invention. In one embodiment, step **230** (see FIG. **2**B) includes the process of FIG. **5**. The process of FIG. **5** starts at step **500**. In step **502**, uninstallation checks tool **116** (see FIG. **1**) determines whether software installer **106** (see FIG. **1**) is an MSI installer (i.e., the computer file of software installer **106** (see FIG. **1**) has an .msi file extension) or an EXE installer (i.e., the computer file of software installer **106** (see FIG. **1**) has an .exe file extension). If uninstallation checks tool **116** (see FIG. **1**) determines in step **502** that software installer **106** (see FIG. **1**) is an MSI installer, then the Yes branch of step **502** is taken and step **504** is performed.

In step **504**, uninstallation checks tool **116** (see FIG. **1**) compares the exit code returned from the uninstallation that finishes in step **226** (see FIG. **2**B) with standard MSI exit codes that can result from executing an MSI installer (i.e., Microsoft® Standard Exit Codes) and determines which of the standard MSI exit codes match the exit code returned from the uninstallation. The comparison performed in step **504** retrieves standard MSI exit codes from data repository **120** (see FIG. **1**). In one embodiment, step **504** also includes uninstallation checks tool **116** (see FIG. **1**) recording the result of the exit code comparison in step **504**, and QA report generator **118** (see FIG. **1**) including the recorded result in QA report **128** (see FIG. **1**).

Prior to step **506** and after the Yes branch of step **502**, uninstallation checks tool **116** (see FIG. **1**) obtains product information (i.e., information about the software application whose uninstallation is being verified) by opening the MSI database resulting from the uninstallation that finishes in step **226** (see FIG. **2**B), and reading and collecting information from the opened database about the software application whose uninstallation is being verified. In one embodiment, the collected information includes a product code identifying the software application.

In step **506**, uninstallation checks tool **116** (see FIG. **1**) executes a product GUID check, which includes uninstallation checks tool **116** (see FIG. **1**) determining whether the product code collected prior to step **506** and after the Yes branch of step **502** does not match a code specifying the software application in a system DLL file of computer system **102** (see FIG. **1**).

In step **508**, uninstallation checks tool **116** (see FIG. **1**) searches for the product name collected prior to step **506** and after the Yes branch of step **502**, where the search is done on log files maintained by the event viewer of the operating system of computer system **102** (see FIG. **1**). The search in step **508** also includes a search of the log files for particular text that indicates the uninstallation is successful or for other text that indicates the uninstallation is unsuccessful. Uninstallation checks tool **116** (see FIG. **1**) determines the uninstallation was successful if the search in step **508** finds the product name in the log files and finds the particular text that indicates a successful uninstallation.

In step **510**, uninstallation checks tool **116** (see FIG. **1**) searches inside the aforementioned MSI database to determine whether a signature file does not exist in the MSI database, where the signature file being searched for is included in configuration file **122** (see FIG. **1**). In one embodiment, step **510** also includes uninstallation checks tool **116** (see FIG. **1**) recording in data repository **120** (see FIG. **1**) the result of the search for the signature file and QA report generator **118** (see FIG. **1**) including the recorded result in QA report **128** (see FIG. **1**).

After step **510** and prior to step **512**, uninstallation checks tool **116** (see FIG. **1**) determines whether the uninstallation of the software application that finished in step **226** (see FIG. **2**B) is successful based on the results of steps **504**, **506**, **508** and **510**. If the comparison in step **504** determines that the exit

code returned from the uninstallation does not match a standard MSI exit code, the product GUID check in step **506** determines that the product code collected prior to step **506** matches a code of the software application retrieved from a DLL file of computer system **102** (see FIG. **1**), the search for the product name in step **508** results in finding error(s) in the product name, and/or step **510** determines that the signature file exists in the MSI database, then uninstallation checks tool **116** (see FIG. **1**) determines that the uninstallation of the software application that was finished in step **226** (see FIG. **2**B) is unsuccessful and the process of FIG. **5** ends at step **512**.

If the comparison in step **504** determines that the exit code returned from the uninstallation matches a standard MSI exit code, the product GUID check in step **506** determines that the product code collected prior to step **506** and after the Yes branch of step **502** does not match a code specifying the software application retrieved from a DLL file of computer system **102** (see FIG. **1**), the product name found in step **508** has no errors, and the signature file searched for in step **510** does not exist, then uninstallation checks tool **116** (see FIG. **1**) determines that the uninstallation of the software application is a success and the process of FIG. **5** ends at step **512**.

Returning to step **502**, if uninstallation checks tool **116** (see FIG. **1**) determines software installer **106** (see FIG. **1**) is an EXE installer, then the No branch of step **502** is taken and step **514** is performed.

In step **514**, uninstallation checks tool **116** (see FIG. **1**) reads the exit code returned from the uninstallation that finished in step **226** (see FIG. **2**B) and compares the returned exit code with exit codes on a standard exit code list that was used for the type of software installer **106** (see FIG. **1**) that was determined in step **502** (i.e., standard exit codes that had been developed for an EXE installer). In one embodiment, the standard exit code list is stored in data repository **120** (see FIG. **1**). In one embodiment, step **514** also includes uninstallation checks tool **116** (see FIG. **1**) recording in data repository **120** (see FIG. **1**) the result of the exit code comparison in step **514**, and QA report generator **118** (see FIG. **1**) including the recorded result in QA report **128** (see FIG. **1**).

Prior to step **516** and after the No branch of step **502**, uninstallation checks tool **116** (see FIG. **1**) extracts product information from a developer's install script or source code for installing the software application. In one embodiment, the extracted product information includes the product name identifying the software application.

In step **516**, uninstallation checks tool **116** (see FIG. **1**) searches for the extracted product name and determines whether the extracted product name does not exist on the uninstall registry key.

In step **518**, uninstallation checks tool **116** (see FIG. **1**) searches for and extracts a location of a signature file on the aforementioned install script or installation source code. Subsequently, uninstallation checks tool **116** (see FIG. **1**) retrieves the signature file whose location was extracted in step **384**. In step **386**, uninstallation checks tool **116** (see FIG. **1**) determines whether the retrieved signature file does not exist in the fourth snapshot of the O/S generated in step **228** (see FIG. **2**B). In one embodiment, step **518** also includes uninstallation checks tool **116** (see FIG. **1**) recording in data repository **120** (see FIG. **1**) the result of the search for the signature file and QA report generator **118** (see FIG. **1**) including the recorded result in QA report **128** (see FIG. **1**).

After step **518** and prior to step **512**, uninstallation checks tool **116** (see FIG. **1**) determines whether the uninstallation is a success based on the results of steps **514**, **516** and **518**. After step **518**, the process of FIG. **5** ends at step **512**.

If uninstallation checks tool **116** (see FIG. **1**) determines in step **514** that the returned exit code matches a standard exit code that indicates a successful uninstallation, the product name searched for in step **516** does not exist in the uninstall registry key, and the signature file searched for in step **518** does not exist in the fourth snapshot of the O/S of computer system **102** (see FIG. **1**), then uninstallation checks tool **116** (see FIG. **1**) determines the uninstallation is successful.

If uninstallation checks tool **116** (see FIG. **1**) determines in step **514** that the returned exit code does not match a standard exit code that indicates a successful uninstallation, the product name searched for in step **516** exists in the uninstall registry key, and/or the signature file searched for in step **518** exists in the fourth snapshot of the O/S of computer system **102** (see FIG. **1**), then uninstallation checks tool **116** (see FIG. **1**) determines the uninstallation is unsuccessful.

Recovering from an Unsuccessful Installation

FIG. **6** is a flowchart of a process of recovering from an unsuccessful installation determined in the process of FIGS. **2**A-**2**B, in accordance with embodiments of the present invention. In one embodiment, step **238** (see FIG. **2**B) includes the process of FIG. **6** and software installer **106** (see FIG. **1**) is an MSI installer. The process of FIG. **6** starts at step **600**. In step **602**, recovery tool **130** (see FIG. **1**) detects a type of error that caused the unsuccessful installation, which is indicated by the flag assigned in step **364** (see FIG. **3**B), indicated by a comparison of the signature files found in steps **370** and **372** in FIG. **3**B, or indicated by the comparison of shortcut paths in step **312** (see FIG. **3**A). The type of error detected in step **602** includes (1) an MSI error exit code (i.e., the comparison in step **358** (see FIG. **3**B) determines that the exit code resulting from the installation matches one of multiple standard MSI exit codes in data repository **120** (see FIG. **1**) (e.g., codes other than the "0" code indicating a successful installation), where each of the standard MSI exit codes indicates a corresponding error; (2) a shortcut error (i.e., the comparison in step **312** (see FIG. **3**A) determines that path(s) of shortcut(s) in configuration file **122** (see FIG. **1**) do not match path(s) of shortcut(s) found in step **310** (see FIG. **3**A); (3) a signature file error (i.e., the signature file is not found in the search in step **370** in FIG. **3**B); or (4) registry error (i.e., the product GUID check in step **360** (see FIG. **3**B) results in not finding a match between the product code collected in step **354** (see FIG. **3**B) and the code retrieved from the DLL file).

In step **604**, recovery tool **130** (see FIG. **1**) determines whether the error type detected in step **602** is (1) an MSI error exit code or (2) a shortcut, signature file, or registry error. If recovery tool **130** (see FIG. **1**) in step **604** determines the error type is an MSI error exit code, then the left branch of step **604** is taken and step **606** is performed.

In step **606**, recovery tool **130** (see FIG. **1**) determines whether the particular error indicated by the MSI error exit code has an automated solution. If recovery tool **130** (see FIG. **1**) determines in step **606** that the error indicated by the MSI error exit code has an automated solution, then the Yes branch of step **606** is taken and step **608** is performed. In one embodiment, data repository **120** (see FIG. **1**) stores an association between the standard MSI error exit codes and respective automated solutions for the errors indicated by the standard MSI error exit codes.

In step **608**, recovery tool **130** (see FIG. **1**) opens the computer file of the MSI installer (i.e., the MSI file) for a write operation. In step **610**, recovery tool **130** (see FIG. **1**) modifies the MSI tables in the MSI file to correct the particular error indicated by the detected MSI error exit code detected in step **602**. In step **612**, recovery tool **130** (see FIG. **1**) closes the

MSI file and assigns a value to a flag indicating the installation was successful. Following step **612**, the process of FIG. **6** ends at step **614**.

Returning to step **606**, if recovery tool **130** (see FIG. **1**) determines that the error indicated by the MSI error exit code does not have an automated solution, then the No branch of step **606** is taken and recover tool **130** (see FIG. **1**) assigns a value to a flag indicating the installation was unsuccessful. Following the No branch of step **606**, the process of FIG. **6** ends at step **616**.

Returning to step **604**, if recovery tool **130** (see FIG. **1**) determines the error type is a shortcut error, signature file error, or registry error, then the right branch of step **604** is taken and step **608** is performed. In step **608** following the right branch of step **604**, recovery tool **130** (see FIG. **1**) opens the MSI file for write operations. In step **610**, recovery tool **130** (see FIG. **1**) modifies the MSI tables in the MSI file to correct the particular error whose type was detected in step **602**. In step **612**, recovery tool **130** (see FIG. **1**) closes the MSI file and assigns a value to a flag indicating the installation was successful. Following step **612**, the process of FIG. **6** ends at step **614**.

Automatically Testing an Application

FIG. **7** is a flowchart of a sub-process of automatically testing an application, which is included in the process of FIG. **3**A, in accordance with embodiments of the present invention. In one embodiment, step **318** (see FIG. **3**A) is replaced with the process of FIG. **7** to provide an automatic test of the software application whose installation is checked in the process of FIG. **3**A. The process of FIG. **7** begins at step **700** after the software application and shortcut(s) to the software application have been installed in step **208** (see FIG. **2**A). In step **702**, installation checks tool **112** (see FIG. **1**) reads a location of an installed shortcut to the installed software application. In one embodiment, the location is read in step **702** from database **126** (see FIG. **1**).

In step **704**, installation checks tool **112** (see FIG. **1**) extracts executable and command line information inside the shortcut whose location was read in step **702**. The extracted executable and command line information indicates how to execute the software application. In one embodiment, the executable and command line information is extracted from database **126** (see FIG. **1**).

In step **706**, by using the executable and command line information extracted in step **704**, installation checks tool **112** (see FIG. **1**) executes the software application to test the software application.

In step **708**, installation checks tool **112** (see FIG. **1**) monitors the software application as it is running and sends a close signal to a window of the software application.

In step **710**, installation checks tool **112** (see FIG. **1**) reads the exit code from the software application.

In step **712**, installation checks tool **112** (see FIG. **1**) determines whether the exit code read in step **710** indicates the software application test was a success or a failure. If installation checks tool **112** (see FIG. **1**) in step **712** determines the exit code read in step **710** indicates the software application test was successful, then the Yes branch of step **712** is taken and step **714** is performed.

In step **714**, installation checks tool **112** (see FIG. **1**) records in data repository **120** (see FIG. **1**) the software application test as being successful.

Returning to step **712**, if installation checks tool **112** (see FIG. **1**) determines that the exit code read in step **710** indicates the software application test was unsuccessful, then the No branch of step **712** is taken and step **716** is performed.

In step **716**, installation checks tool **112** (see FIG. **1**) records in data repository **120** (see FIG. **1**) the software application test as being unsuccessful.

Step **718** is performed after step **714** and after step **716**. In step **718**, installation checks tool **112** (see FIG. **1**) determines whether there is another shortcut to the software application that is not yet tested in the process of FIG. **7**. If installation checks tool **112** (see FIG. **1**) determines in step **718** that there is another shortcut to be tested, then the Yes branch of step **718** is taken and the process repeats starting at step **702**. Otherwise, if there are no other shortcuts to be tested, then the No branch of step **718** is taken and the process of FIG. **7** ends at step **720**. In one embodiment, installation checks tool **112** (see FIG. **1**) determines whether there is another shortcut to be tested by identifying the shortcuts to be tested from shortcut information stored in database **126** (see FIG. **1**).

Computer System

FIG. **8** is a block diagram of a computer system included in the system of FIG. **1** and that implements the processes of FIGS. **2**A-**2**B, FIG. **3**A, FIG. **3**B, FIG. **4**, FIG. **5**, FIG. **6**, and FIG. **7**, in accordance with embodiments of the present invention. Computer system **102** generally includes a central processing unit (CPU) **802**, a memory **804**, an input/output (I/O) interface **806**, and a bus **808**. Further, computer system **102** is coupled to I/O devices **810** and a computer data storage unit **812**. CPU **802** performs computation and control functions of computer system **102**, including executing instructions included in program code **814**, **816** and **818** to perform a method of assuring quality of a software installer, where the instructions are executed by CPU **802** via memory **804**. CPU **802** may include a single processing unit, or be distributed across one or more processing units in one or more locations (e.g., on a client and server). Program code **814** includes program code for QA tool **104** (see FIG. **1**). Program code **816** includes program code for software installer **106** (see FIG. **1**). Program code **818** includes program code for recovery tool **130** (see FIG. **1**).

Memory **804** includes a known computer-readable storage medium, which is described below. In one embodiment, cache memory elements of memory **804** provide temporary storage of at least some program code (e.g., program code **814**, **816** and **818**) in order to reduce the number of times code must be retrieved from bulk storage while instructions of the program code are executed. Moreover, similar to CPU **802**, memory **804** may reside at a single physical location, including one or more types of data storage, or be distributed across a plurality of physical systems in various forms. Further, memory **804** can include data distributed across, for example, a local area network (LAN) or a wide area network (WAN).

I/O interface **806** includes any system for exchanging information to or from an external source. I/O devices **810** include any known type of external device, including a display device (e.g., monitor), keyboard, mouse, printer, speakers, handheld device, facsimile, etc. I/O devices **810** includes display device **118** (see FIG. **1**). Bus **808** provides a communication link between each of the components in computer system **102**, and may include any type of transmission link, including electrical, optical, wireless, etc.

I/O interface **806** also allows computer system **102** to store information (e.g., data or program instructions such as program code **814**, **816** and **818**) on and retrieve the information from computer data storage unit **812** or another computer data storage unit (not shown). In one embodiment, program code **814**, **816** and **818** are stored on computer data storage unit **812**. Computer data storage unit **812** includes a known computer-readable storage medium, which is described below. For example, computer data storage unit **812** may be a non-

volatile data storage device, such as a magnetic disk drive (i.e., hard disk drive) or an optical disc drive (e.g., a CD-ROM drive which receives a CD-ROM disk).

Memory **804** and/or storage unit **812** may store computer program code **814**, **816** and **818** that includes instructions that are carried out by CPU **802** via memory **804** to assure quality of a software installer. Although FIG. **8** depicts memory **804** as including program code **814**, **816** and **818**, the present invention contemplates embodiments in which memory **804** does not include all of code **814**, **816** and **818** simultaneously, but instead at one time includes only a portion of code **814**, a portion of code **816** and/or a portion of code **818**.

Further, memory **804** may include other systems not shown in FIG. **8**, such as an operating system (e.g., Linux®) that runs on CPU **802** and provides control of various components within and/or connected to computer system **102**. Linux is a registered trademark of Linus Torvalds in the United States, other countries, or both.

Storage unit **812** and/or one or more other computer data storage units (not shown) that are coupled to computer system **102** may store configuration file **122** (see FIG. **1**), O/S snapshots **124** (see FIG. **1**) and database **126**. In embodiment, storage unit **812** includes data repository **120** (see FIG. **1**).

As will be appreciated by one skilled in the art, in a first embodiment, the present invention may be a system; in a second embodiment, the present invention may be a method; and in a third embodiment, the present invention may be a computer program product. A component of an embodiment of the present invention may take the form of an entirely hardware-based component, an entirely software component (including firmware, resident software, micro-code, etc.) or a component combining software and hardware sub-components that may all generally be referred to herein as a "module".

An embodiment of the present invention may take the form of a computer program product embodied in one or more computer-readable medium(s) (e.g., memory **804** and/or computer data storage unit **812**) having computer-readable program code (e.g., program code **814**, **816** and **818**) embodied or stored thereon.

Any combination of one or more computer-readable mediums (e.g., memory **804** and computer data storage unit **812**) may be utilized. The computer-readable medium may be (1) a computer-readable storage medium, or (2) a computer-readable signal medium. As used herein, a computer-readable storage medium is not a computer-readable signal medium.

In one embodiment, the computer-readable storage medium is a physical, tangible computer-readable storage device or physical, tangible computer-readable storage apparatus that stores but does not propagate. A computer-readable storage medium may include, for example, an electronic, magnetic, optical, electromagnetic, or semiconductor system, apparatus, device or any suitable combination of the foregoing. A non-exhaustive list of more specific examples of the computer-readable storage medium includes: a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), an optical fiber, a portable compact disc read-only memory (CD-ROM), an optical storage device, a magnetic storage device, or any suitable combination of the foregoing. In the context of this document, a computer-readable storage medium is a physical, tangible storage medium that can contain or store a program (e.g., program **814**, **816** and **818**) for use by or in connection with a system, apparatus, or device for carrying out instructions in the program, and which does not propagate. As used herein, a computer-readable storage medium is not a computer-readable signal medium.

A computer-readable signal medium may include a propagated data signal with computer-readable program code embodied therein, for example, in baseband or as part of a carrier wave. Such a propagated signal may take any of a variety of forms, including, but not limited to, electromagnetic, optical, or any suitable combination thereof. A computer-readable signal medium may be any computer-readable medium that is not a computer-readable storage medium and that can communicate, propagate, or transport a program for use by or in connection with a system, apparatus, or device for carrying out instructions.

Program code (e.g., program code **814**, **816** and **818**) embodied on a computer-readable medium may be transmitted using any appropriate medium, including but not limited to wireless, wireline, optical fiber cable, radio frequency (RF), etc., or any suitable combination of the foregoing.

Computer program code (e.g., program code **814**, **816** and **818**) for carrying out operations for aspects of the present invention may be written in any combination of one or more programming languages, including an object oriented programming language such as Java®, Smalltalk, C++ or the like and conventional procedural programming languages, such as the "C" programming language or similar programming languages. Java and all Java-based trademarks are trademarks or registered trademarks of Oracle and/or its affiliates. Instructions of the program code may be carried out entirely on a user's computer, partly on the user's computer, as a stand-alone software package, partly on the user's computer and partly on a remote computer or entirely on the remote computer or server, where the aforementioned user's computer, remote computer and server may be, for example, computer system **102** or another computer system (not shown) having components analogous to the components of computer system **102** included in FIG. **8**. In the latter scenario, the remote computer may be connected to the user's computer through any type of network (not shown), including a LAN or a WAN, or the connection may be made to an external computer (e.g., through the Internet using an Internet Service Provider).

Aspects of the present invention are described herein with reference to flowchart illustrations (e.g., FIGS. **2**A-**2**B, FIG. **3**A, FIG. **3**B, FIG. **4**, FIG. **5**, FIG. **6**, and FIG. **7**) and/or block diagrams of methods, apparatus (systems) (e.g., FIG. **1** and FIG. **8**), and computer program products according to embodiments of the invention. It will be understood that each block of the flowchart illustrations and/or block diagrams, and combinations of blocks in the flowchart illustrations and/or block diagrams, can be implemented by computer program instructions (e.g., program code **814**, **816** and **818**). These computer program instructions may be provided to one or more hardware processors (e.g., CPU **802**) of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which are carried out via the processor(s) of the computer or other programmable data processing apparatus, create means for implementing the functions/acts specified in the flowcharts and/or block diagram block or blocks.

These computer program instructions may also be stored in a computer-readable medium (e.g., memory **804** or computer data storage unit **812**) that can direct a computer (e.g., computer system **102**), other programmable data processing apparatus, or other devices to function in a particular manner, such that the instructions (e.g., program **814**, **816** and **818**) stored in the computer-readable medium produce an article of

manufacture including instructions which implement the function/act specified in the flowcharts and/or block diagram block or blocks.

The computer program instructions may also be loaded onto a computer (e.g., computer system **102**), other programmable data processing apparatus, or other devices to cause a series of operational steps to be performed on the computer, other programmable apparatus, or other devices to produce a computer-implemented process such that the instructions (e.g., program **814**, **816** and **818**) which are executed on the computer, other programmable apparatus, or other devices provide processes for implementing the functions/acts specified in the flowcharts and/or block diagram block or blocks.

Any of the components of an embodiment of the present invention can be deployed, managed, serviced, etc. by a service provider that offers to deploy or integrate computing infrastructure with respect to assuring quality of a software installer. Thus, an embodiment of the present invention discloses a process for supporting computer infrastructure, where the process includes providing at least one support service for at least one of integrating, hosting, maintaining and deploying computer-readable code (e.g., program code **814**, **816** and **818**) in a computer system (e.g., computer system **102**) including one or more processors (e.g., CPU **802**), wherein the processor(s) carry out instructions contained in the code causing the computer system to assure quality of a software installer. Another embodiment discloses a process for supporting computer infrastructure, where the process includes integrating computer-readable program code into a computer system including a processor. The step of integrating includes storing the program code in a computer-readable storage device of the computer system through use of the processor. The program code, upon being executed by the processor, implements a method of assuring quality of a software installer.

While it is understood that program code **814**, **816** and **818** for assuring quality of a software installer may be deployed by manually loading directly in client, server and proxy computers (not shown) via loading a computer-readable storage medium (e.g., computer data storage unit **812**), program code **814**, **816** and **818** may also be automatically or semi-automatically deployed into computer system **102** by sending program code **814**, **816** and **818** to a central server (e.g., computer system **102**) or a group of central servers. Program code **814**, **816** and **818** is then downloaded into client computers (not shown) that will execute program code **814**, **816** and **818**. Alternatively, program code **814**, **816** and **818** is sent directly to the client computer via e-mail. Program code **814**, **816** and **818** is then either detached to a directory on the client computer or loaded into a directory on the client computer by a button on the e-mail that executes a program that detaches program code **814**, **816** and **818** into a directory. Another alternative is to send program code **814**, **816** and **818** directly to a directory on the client computer hard drive. In a case in which there are proxy servers, the process selects the proxy server code, determines on which computers to place the proxy servers' code, transmits the proxy server code, and then installs the proxy server code on the proxy computer. Program code **814**, **816** and **818** is transmitted to the proxy server and then it is stored on the proxy server.

In one embodiment, program code **814**, **816** and **818** is integrated into a client, server and network environment by providing for program code **814**, **816** and **818** to coexist with software applications (not shown), operating systems (not shown) and network operating systems software (not shown) and then installing program code **814**, **816** and **818** on the clients and servers in the environment where program code **814**, **816** and **818** will function.

The first step of the aforementioned integration of code included in program code **814**, **816** and **818** is to identify any software on the clients and servers including the network operating system (not shown) where program code **814**, **816** and **818** will be deployed that are required by program code **814**, **816** and **818** or that work in conjunction with program code **814**, **816** and **818**. This identified software includes the network operating system that is software that enhances a basic operating system by adding networking features. Next, the software applications and version numbers are identified and compared to the list of software applications and version numbers that have been tested to work with program code **814**, **816** and **818**. Those software applications that are missing or that do not match the correct version are upgraded with the correct version numbers. Program instructions that pass parameters from program code **814**, **816** and **818** to the software applications are checked to ensure the parameter lists match the parameter lists required by the program code **814**, **816** and **818**. Conversely, parameters passed by the software applications to program code **814**, **816** and **818** are checked to ensure the parameters match the parameters required by program code **814**, **816** and **818**. The client and server operating systems including the network operating systems are identified and compared to the list of operating systems, version numbers and network software that have been tested to work with program code **814**, **816** and **818**. Those operating systems, version numbers and network software that do not match the list of tested operating systems and version numbers are upgraded on the clients and servers to the required level. After ensuring that the software, where program code **814**, **816** and **818** is to be deployed, is at the correct version level that has been tested to work with program code **814**, **816** and **818**, the integration is completed by installing program code **814**, **816** and **818** on the clients and servers.

Another embodiment of the invention provides a method that performs the process steps on a subscription, advertising and/or fee basis. That is, a service provider, such as a Solution Integrator, can offer to create, maintain, support, etc. a process of assuring quality of a software installer. In this case, the service provider can create, maintain, support, etc. a computer infrastructure that performs the process steps for one or more customers. In return, the service provider can receive payment from the customer(s) under a subscription and/or fee agreement, and/or the service provider can receive payment from the sale of advertising content to one or more third parties.

The flowcharts in FIGS. **2**A-**2**B, FIG. **3**A, FIG. **3**B, FIG. **4**, FIG. **5**, FIG. **6**, and FIG. **7** and the block diagrams in FIG. **1** and FIG. **8** illustrate the architecture, functionality, and operation of possible implementations of systems, methods, and computer program products according to various embodiments of the present invention. In this regard, each block in the flowcharts or block diagrams may represent a module, segment, or portion of code (e.g., program code **814**, **816** or **818**), which includes one or more executable instructions for implementing the specified logical function(s). It should also be noted that, in some alternative implementations, the functions noted in the block may occur out of the order noted in the figures. For example, two blocks shown in succession may, in fact, be performed substantially concurrently, or the blocks may sometimes be performed in reverse order, depending upon the functionality involved. It will also be noted that each block of the block diagrams and/or flowchart illustrations, and combinations of blocks in the block diagrams and/or flowchart illustrations, can be implemented by special pur-

pose hardware-based systems that perform the specified functions or acts, or combinations of special purpose hardware and computer instructions.

While embodiments of the present invention have been described herein for purposes of illustration, many modifications and changes will become apparent to those skilled in the art. Accordingly, the appended claims are intended to encompass all such modifications and changes as fall within the true spirit and scope of this invention.

The invention claimed is:

1. A method of managing a software installer, the method comprising the steps of:

a computer determining and recording a change between first and second views of an operating system of the computer, information representative of the second view being recorded subsequent to an execution of the software installer to create installed components in an installation of a software application;

based on the change, the computer recording information about the installed components;

the computer performing checks on the installation;

based on the checks on the installation, the computer making a determination that the installation was successful;

responsive to the determination that the installation was successful, the computer removing selected installed components;

the computer executing the software installer to perform a reinstallation of the selected installed components that had been removed;

the computer performing checks on the reinstallation;

subsequent to the step of executing the software installer to perform the reinstallation, the computer recording information representative of a third view of the operating system;

the computer executing an uninstaller to perform an uninstallation of the software application;

subsequent to the step of executing the uninstaller, the computer recording information representative of a fourth view of the operating system;

the computer performing checks on the uninstallation;

responsive to the step of making the determination that the installation was successful, the computer determining a location for an installed shortcut for the software application;

using the location, the computer extracting executable and command line information inside the shortcut;

based on the extracted executable and command line information, the computer executing the software application to perform a test of the software application;

while the software application is executing, the computer sending a close signal to a window of the software application;

responsive to the step of sending the close signal, the computer reading an exit code from the software application;

the computer determining whether the exit code matches a standard exit code indicating the test of the software application was successful; and

responsive to a determination the exit code matches the standard exit code indicating the test of the software application was successful, the computer documenting in a report that the test of the software application is successful; or responsive to a determination the exit code does not match the standard exit code, the computer documenting in the report that the test of the software application was unsuccessful.

2. The method of claim **1**, further comprising the step of prior to the execution of the software installer to create the installed components, the computer reading a configuration file, wherein the step of performing the checks on the installation includes:

the computer determining an extension of a file name of the software installer is .msi; and

responsive to the step of determining the extension of the file name of the software installer is .msi:

the computer determining whether a second exit code returned from the installation matches a second standard exit code indicating the installation was successful based on the extension being .msi;

the computer determining whether an event view of the operating system includes a product name identifying the software application;

the computer determining whether a signature file in the configuration file is included in the recorded information about the installed components; and

responsive to a determination that the second exit code matches the second standard exit code, the event view includes the product name, and the signature file is included in the recorded information about the installed components, the computer determining the installation was successful; or responsive to a determination that the second exit code does not match the second standard exit code, the event view does not include the product name or the signature file is not included in the recorded information about the installed components, the computer determining the installation was unsuccessful.

3. The method of claim **1**, wherein the step of performing the checks on the installation includes:

the computer determining an extension of a file name of the software installer is .exe; and

responsive to the step of determining the extension of the file name of the software installer is .exe:

the computer determining whether a second exit code returned from the installation matches a second standard exit code indicating the installation was successful based on the extension being .exe;

the computer extracting a product name identifying the software application from a script or a source code providing the installation;

the computer determining whether the extracted product name matches a product name in an uninstall registry key; and

responsive to a determination that the second exit code matches the second standard exit code and the extracted product name matches the product name in the uninstall registry key, the computer determining the installation was successful; or responsive to a determination that the second exit code does not match the second standard exit code and the extracted product name does not match the product name in the uninstall registry key, the computer determining the installation was unsuccessful.

4. The method of claim **1**, further comprising the steps of:

based on checks on another installation of the software application, the computer determining the other installation was unsuccessful by the computer determining a second exit code returned from the other installation does not match the standard exit code;

the computer determining the second exit code indicates an existence of an automated recovery from the other installation that was unsuccessful;

the computer opening a file of the software installer for write operations;

the computer modifying tables in the file to perform the automated recovery;

the computer closing the file; and

the computer designating the automated recovery as successful.

5. The method of claim **1**, further comprising the steps of:

based on checks on another installation of the software application, the computer determining the other installation was unsuccessful by determining a signature file in a configuration file is included in the recorded information about the installed components, determining a product name extracted from a script of a source code providing the other installation does not match the product name in an uninstall registry key, or determining a second exit code indicates a test of closing a window of the software application is unsuccessful, the test using executable and command line information extracted from an installed shortcut of the software application;

the computer opening a file of the software installer for write operations;

the computer modifying tables in the file to perform an automated recovery from the installation that was unsuccessful;

the computer closing the file; and

the computer designating the automated recovery as successful.

6. The method of claim **1**, wherein the step of performing the checks on the reinstallation includes:

the computer determining a second exit code returned from the reinstallation matches a second standard exit code indicating the reinstallation was successful;

the computer determining the selected installed components that had been removed were subsequently restored in the reinstallation;

the computer searching for and locating one or more messages in an event viewer of the operating system, the one or more messages including a product name of the software installer; and

the computer adding to the report information about the second exit code matching the second standard exit code indicating the reinstallation was successful, the selected installed components being restored, and the one or more messages including the product name of the software installer.

7. The method of claim **1**, wherein the step of performing the checks on the uninstallation includes:

the computer determining an extension of a file name of the software installer is .msi; and

responsive to the step of determining the extension of the file name of the software installer is .msi:

the computer determining a second exit code returned from the uninstallation matches a second standard exit code indicating the uninstallation was successful;

the computer determining a product code for the installed components does not exist in the fourth view of the operating system;

the computer determining an event view of the operating system does not include a product name identifying the software application; and

the computer determining a signature file in a configuration file is not included in the fourth view of the operating system.

8. The method of claim **1**, wherein the step of performing the checks on the uninstallation includes:

the computer determining an extension of a file name of the software installer is .exe; and

responsive to the step of determining the extension of the file name of the software installer is .exe:

the computer determining a second exit code returned from the uninstallation matches a second standard exit code indicating the uninstallation was successful;

the computer extracting a product name identifying the software application from a script or a source code providing the installation;

the computer determining the extracted product name does not exist in an uninstall registry key; and

the computer determining a signature file in a configuration file is not included in the fourth view of the operating system.

9. The method of claim **1**, further comprising the step of:

providing at least one support service for at least one of creating, integrating, hosting, maintaining, and deploying computer-readable program code in the computer, the program code being executed by a processor of the computer to implement the steps of determining and recording the change between the first and second views of the operating system, recording information about the installed components, performing the checks on the installation, making the determination that the installation was successful, removing selected installed components, executing the software installer to perform the reinstallation of the selected installed components, performing the checks on the reinstallation, recording the information representative of the third view of the operating system, executing the uninstaller, recording information representative of the fourth view of the operating system, performing the checks on the uninstallation, determining the location, extracting the executable and command line information, executing the software application to perform the test of the software application, sending the close signal, reading the exit code, determining whether the exit code matches the standard exit code, and documenting that the test of the software application is successful or unsuccessful.

10. A computer system comprising:

a central processing unit (CPU);

a memory coupled to the CPU;

a computer-readable, tangible storage device coupled to the CPU, the storage device containing instructions that are executed by the CPU via the memory to implement a method of managing a software installer, the method comprising the steps of:

the computer system determining and recording a change between first and second views of an operating system of the computer, information representative of the second view being recorded subsequent to an execution of the software installer to create installed components in an installation of a software application;

based on the change, the computer system recording information about the installed components;

the computer system performing checks on the installation;

based on the checks on the installation, the computer system making a determination that the installation was successful;

responsive to the determination that the installation was successful, the computer system removing selected installed components;

the computer system executing the software installer to perform a reinstallation of the selected installed components that had been removed;

the computer system performing checks on the reinstallation;

subsequent to the step of executing the software installer to perform the reinstallation, the computer system recording information representative of a third view of the operating system;

the computer system executing an uninstaller to perform an uninstallation of the software application;

subsequent to the step of executing the uninstaller, the computer system recording information representative of a fourth view of the operating system;

the computer system performing checks on the uninstallation;

responsive to the step of making the determination that the installation was successful, the computer system determining a location for an installed shortcut for the software application;

using the location, the computer system extracting executable and command line information inside the shortcut;

based on the extracted executable and command line information, the computer system executing the software application to perform a test of the software application;

while the software application is executing, the computer system sending a close signal to a window of the software application;

responsive to the step of sending the close signal, the computer system reading an exit code from the software application;

the computer system determining whether the exit code matches a standard exit code indicating the test of the software application was successful; and

responsive to a determination the exit code matches the standard exit code indicating the test of the software application was successful, the computer system documenting in a report that the test of the software application is successful; or responsive to a determination the exit code does not match the standard exit code, the computer system documenting in the report that the test of the software application was unsuccessful.

11. The computer system of claim **10**, wherein the method further comprises prior to the execution of the software installer to create the installed components, the computer system reading a configuration file, wherein the step of performing the checks on the installation includes:

the computer system determining an extension of a file name of the software installer is .msi; and

responsive to the step of determining the extension of the file name of the software installer is .msi:

the computer system determining whether a second exit code returned from the installation matches a second standard exit code indicating the installation was successful based on the extension being .msi;

the computer system determining whether an event view of the operating system includes a product name identifying the software application;

the computer system determining whether a signature file in the configuration file is included in the recorded information about the installed components; and

responsive to a determination that the second exit code matches the second standard exit code, the event view includes the product name, and the signature file is included in the recorded information about the installed components, the computer system determining the installation was successful; or responsive to a determination that the second exit code does not match the second standard exit code, the event view does not include the product name or the signature file is not included in the recorded information about the installed components, the computer system determining the installation was unsuccessful.

12. The computer system of claim **10**, wherein the step of performing the checks on the installation includes:

the computer system determining an extension of a file name of the software installer is .exe; and

responsive to the step of determining the extension of the file name of the software installer is .exe:

the computer system determining whether a second exit code returned from the installation matches a second standard exit code indicating the installation was successful based on the extension being .exe;

the computer system extracting a product name identifying the software application from a script or a source code providing the installation;

the computer system determining whether the extracted product name matches a product name in an uninstall registry key; and

responsive to a determination that the second exit code matches the second standard exit code and the extracted product name matches the product name in the uninstall registry key, the computer system determining the installation was successful; or responsive to a determination that the second exit code does not match the second standard exit code and the extracted product name does not match the product name in the uninstall registry key, the computer system determining the installation was unsuccessful.

13. The computer system of claim **10**, wherein the method further comprises the steps of:

based on checks on another installation of the software application, the computer determining the other installation was unsuccessful by the computer determining a second exit code returned from the other installation does not match the standard exit code;

the computer determining the second exit code indicates an existence of an automated recovery from the other installation that was unsuccessful;

the computer opening a file of the software installer for write operations;

the computer modifying tables in the file to perform the automated recovery;

the computer closing the file; and

the computer designating the automated recovery as successful.

14. The computer system of claim **10**, wherein the method further comprises the steps of:

based on checks on another installation of the software application, the computer determining the other installation was unsuccessful by determining a signature file in a configuration file is included in the recorded information about the installed components, determining a product name extracted from a script of a source code providing the other installation does not match the product name in an uninstall registry key, or determining a second exit code indicates a test of closing a window of the software application is unsuccessful, the test using executable and command line information extracted from an installed shortcut of the software application;

the computer opening a file of the software installer for write operations;

the computer modifying tables in the file to perform an automated recovery from the installation that was unsuccessful;

the computer closing the file; and

the computer designating the automated recovery as successful.

15. The computer system of claim **10**, wherein the step of performing the checks on the reinstallation includes:

the computer determining a second exit code returned from the reinstallation matches a second standard exit code indicating the reinstallation was successful;

the computer determining the selected installed components that had been removed were subsequently restored in the reinstallation;

the computer searching for and locating one or more messages in an event viewer of the operating system, the one or more messages including a product name of the software installer; and

the computer adding to the report information about the second exit code matching the second standard exit code indicating the reinstallation was successful, the selected installed components being restored, and the one or more messages including the product name of the software installer.

16. A computer program product, comprising:

a computer-readable storage device that is not a transitory signal; and

a computer-readable program code stored in the computer-readable storage device that is not a transitory signal, the computer-readable program code containing instructions that are executed by a central processing unit (CPU) of a computer system to implement a method of managing a software installer, the method comprising the steps of:

the computer system determining and recording a change between first and second views of an operating system of the computer, information representative of the second view being recorded subsequent to an execution of the software installer to create installed components in an installation of a software application;

based on the change, the computer system recording information about the installed components;

the computer system performing checks on the installation;

based on the checks on the installation, the computer system making a determination that the installation was successful;

responsive to the determination that the installation was successful, the computer system removing selected installed components;

the computer system executing the software installer to perform a reinstallation of the selected installed components that had been removed;

the computer system performing checks on the reinstallation;

subsequent to the step of executing the software installer to perform the reinstallation, the computer system recording information representative of a third view of the operating system;

the computer system executing an uninstaller to perform an uninstallation of the software application;

subsequent to the step of executing the uninstaller, the computer system recording information representative of a fourth view of the operating system;

the computer system performing checks on the uninstallation;

responsive to the step of making the determination that the installation was successful, the computer system determining a location for an installed shortcut for the software application;

using the location, the computer system extracting executable and command line information inside the shortcut;

based on the extracted executable and command line information, the computer system executing the software application to perform a test of the software application;

while the software application is executing, the computer system sending a close signal to a window of the software application;

responsive to the step of sending the close signal, the computer system reading an exit code from the software application;

the computer system determining whether the exit code matches a standard exit code indicating the test of the software application was successful; and

responsive to a determination the exit code matches the standard exit code indicating the test of the software application was successful, the computer system documenting in a report that the test of the software application is successful; or responsive to a determination the exit code does not match the standard exit code, the computer system documenting in the report that the test of the software application was unsuccessful.

17. The program product of claim **16**, wherein the method further comprises the step of prior to the execution of the software installer to create the installed components, the computer system reading a configuration file, wherein the step of performing the checks on the installation includes:

the computer system determining an extension of a file name of the software installer is .msi; and

responsive to the step of determining the extension of the file name of the software installer is .msi:

the computer system determining whether a second exit code returned from the installation matches a second standard exit code indicating the installation was successful based on the extension being .msi;

the computer system determining whether an event view of the operating system includes a product name identifying the software application;

the computer system determining whether a signature file in the configuration file is included in the recorded information about the installed components; and

responsive to a determination that the second exit code matches the second standard exit code, the event view includes the product name, and the signature file is included in the recorded information about the installed components, the computer system determining the installation was successful; or responsive to a determination that the second exit code does not match the second standard exit code, the event view does not include the product name or the signature file is not included in the recorded information about the installed components, the computer system determining the installation was unsuccessful.

18. The program product of claim **16**, wherein the step of performing the checks on the installation includes:

the computer system determining an extension of a file name of the software installer is .exe; and

responsive to the step of determining the extension of the file name of the software installer is .exe:

the computer system determining whether a second exit code returned from the installation matches a second

standard exit code indicating the installation was successful based on the extension being .exe;

the computer system extracting a product name identifying the software application from a script or a source code providing the installation;

the computer system determining whether the extracted product name matches a product name in an uninstall registry key; and

responsive to a determination that the second exit code matches the second standard exit code and the extracted product name matches the product name in the uninstall registry key, the computer system determining the installation was successful; or responsive to a determination that the second exit code does not match the second standard exit code and the extracted product name does not match the product name in the uninstall registry key, the computer system determining the installation was unsuccessful.

19. The program product of claim **16**, wherein the method further comprises the steps of:

based on checks on another installation of the software application, the computer determining the other installation was unsuccessful by the computer determining a second exit code returned from the other installation does not match the standard exit code;

the computer determining the second exit code indicates an existence of an automated recovery from the other installation that was unsuccessful;

the computer opening a file of the software installer for write operations;

the computer modifying tables in the file to perform the automated recovery;

the computer closing the file; and

the computer designating the automated recovery as successful.

20. The program product of claim **16**, wherein the method further comprises the steps of:

based on checks on another installation of the software application, the computer determining the other installation was unsuccessful by determining a signature file in a configuration file is included in the recorded information about the installed components, determining a product name extracted from a script of a source code providing the other installation does not match the product name in an uninstall registry key, or determining a second exit code indicates a test of closing a window of the software application is unsuccessful, the test using executable and command line information extracted from an installed shortcut of the software application;

the computer opening a file of the software installer for write operations;

the computer modifying tables in the file to perform an automated recovery from the installation that was unsuccessful;

the computer closing the file; and

the computer designating the automated recovery as successful.

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